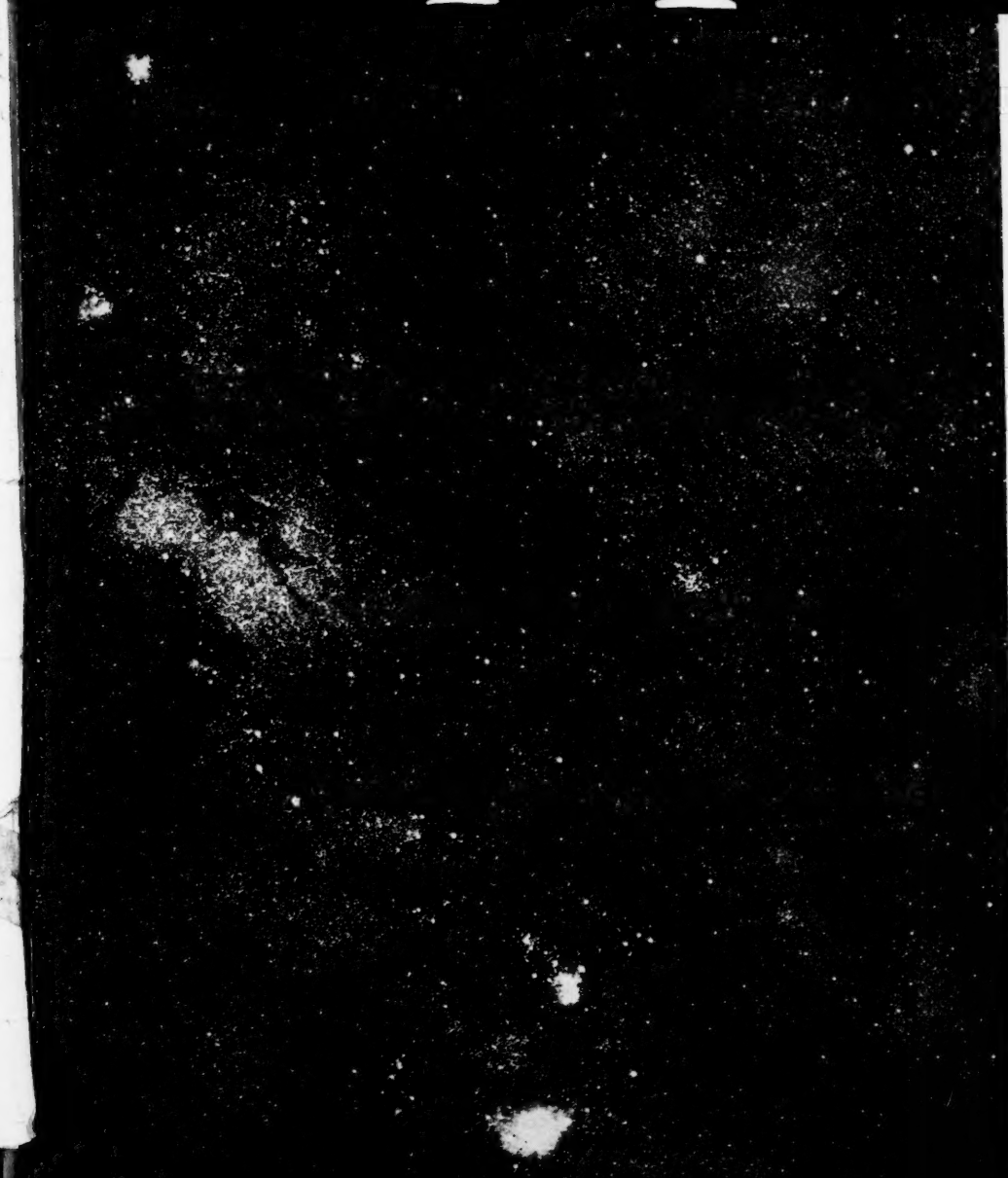
the review of POPULAR A



FORMERLY . . . THE MONTHLY EVENING SKY MAP

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★ Sizing Up the Supergiants

★ Through the Three-Inch

★ Useful Magnifications

★ Outer Space Photography

★ That First Telescope

VOL. LV NO. 511

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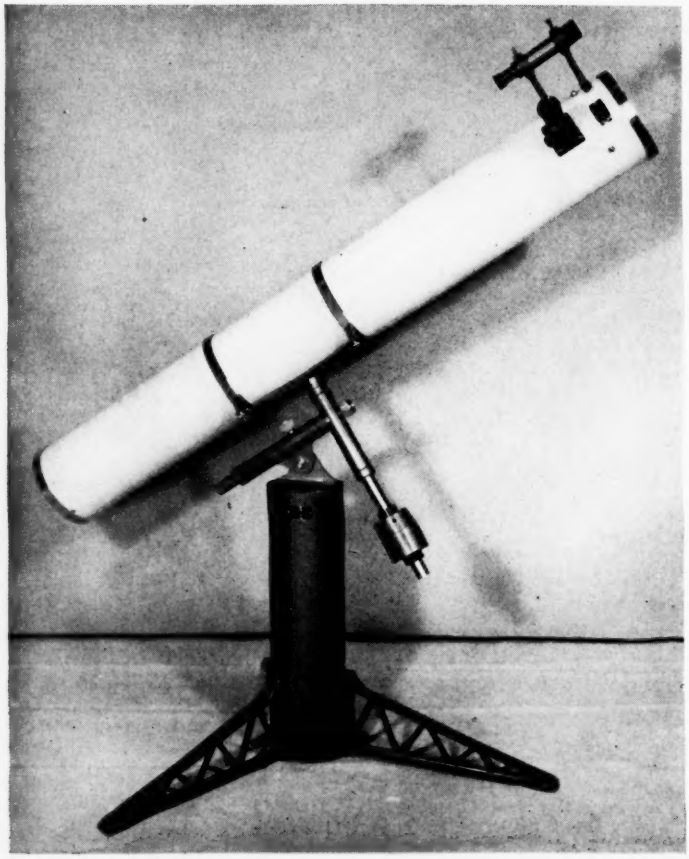

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FORMERLY THE
MONTHLY EVENING SKY MAP

the review of POPULAR ASTRONOMY

MAY-JUNE 1961
VOL. LV WHOLE NUMBER 511

THE REVIEW OF POPULAR ASTRONOMY

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COVER PHOTO

Our cover photograph shows the rich region to the north of the great star-cloud in Sagittarius. Photo is from the Ross-Calvert *Atlas of the Northern Milky Way*, University of Chicago.

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Articles, letters, photographs and other communications are encouraged and will be given the attention of the editors, although we cannot be responsible for their return in the case of unsolicited articles. All articles, photos, charts and other editorial matter in the magazine are protected by copyright, and permission must be obtained from the publisher for their use in other publications.

THE AMATEUR'S FORUM

The Editors
REVIEW OF POPULAR ASTRONOMY

In connection with the photograph of the University of Michigan's 85-foot radio telescope on page nine of your March-April issue, I send you this photograph of the 60-foot dish of the Carnegie Institution of Washington located at Redlands, Md.

Courtesy **The Amateur Scientist**

Some years ago, funds were allocated for the purchase of an 85-foot dish by the Institution, but none of the plans then in existence met their rather rigid specifications. Accordingly, their engineers came up with a basic design to meet their own specifications. The present manufacturer completed the engineering work on the design in such detail that the final plans were properly considered his proprietary product.

The design was so good (the paraboloidal surface is accurate to within 1/16-inch, and each segment is separately adjustable at all four corners) that the manufacturer sold several to other purchasers. But by the time the plans were complete, steel and labor costs had risen to the point where CIW's budget was no longer adequate for an 85-foot dish, and they had to settle for a 60.

There are in the neighborhood of ten 85's in the field at the present time, but the Carnegie Institution, father of the project, wound up with the runt of the litter. There is a moral here somewhere, but I don't know what it is.

Nelson M. Griggs
Editor, THE AMATEUR SCIENTIST
Old Baltimore Road
Boyds, Maryland

Dear Sirs:

I like your magazine very much. I hope your magazine grows to be the biggest, best, and most popular magazine that one on astronomy could be. I'm sure that it will be a great success in the future.

Gary Philip Campel
Deer Park Road
New Canaan, Conn.

Dear Sirs:

I have a recent number of your new magazine and am very much pleased with it. I note that the new chart of heliocentric positions of the planets has slightly larger letters, which is good. The pictures of the nebulas are excellent. The equatorial sky map is most useful. One wishes that the numbers at the top and bottom were larger. Old eyes like mine have to use a reading glass sometimes. The scope of the magazine is good. It is a good idea (suitable) to have part of the cover in blue. Even the advertisements are of interest. Altogether the magazine is well adapted to the rank and file, who will enjoy it greatly. Best wishes for continued and increasing success.

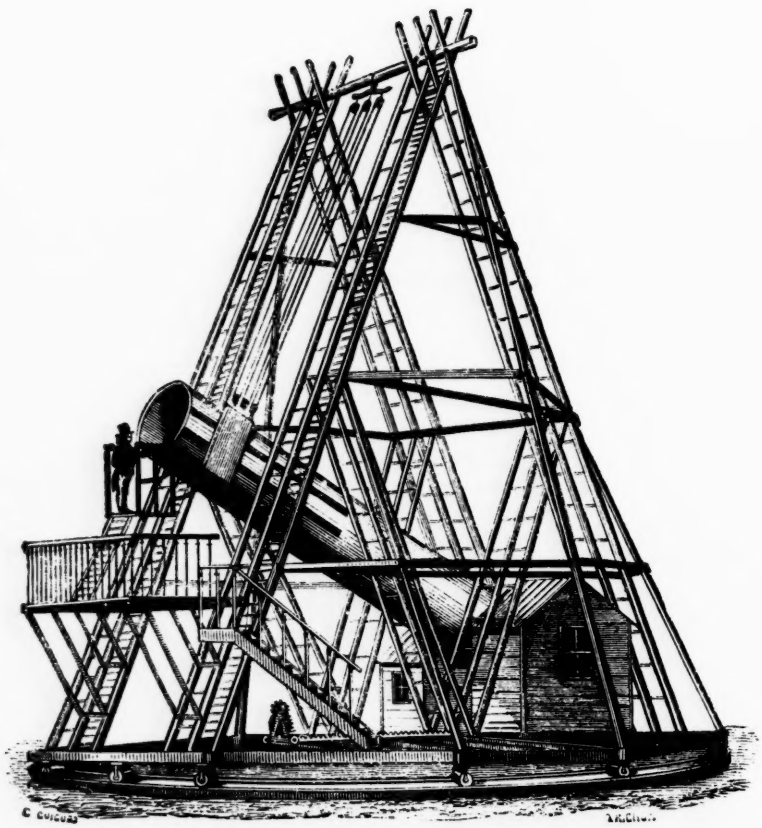
Henry M. Allen
35 Easterly Ave.
Auburn, N.Y.

HERSCHEL . . .

amateur of astronomy

A reminder of the true meaning of the word "amateur," as defined by the life of Sir William Herschel

By Armand N. Spitz



IF THE AMATEUR astronomers of the world have a patron saint, that man is Frederick William Herschel, the prototype of the hundreds of thousands of modern non-professional star-gazers, who find in his life a stirring example of devotion to a cause.

There have been musicians since the earliest days of history, but it remained for Herschel to travel by gradual steps from popularity and distinction as a musician and music-master to even greater popularity and distinction as an astronomer. Today

Herschel's 48-inch reflector, grandest of its time. Built at Bath, England, the instrument was used well by Herschel, but was found a bit unwieldy. Most of Herschel's routine work was accomplished with smaller telescopes. From an old engraving.

No astronomer plunged as relentlessly and effectively into the realm of the unknown as William Herschel. Certainly few astronomers have combined observational skill and theoretical insight to the extent of this one-time organist of Bath. An inseparable companion to the end of his years was his sister, Caroline, who also made many contributions to astronomy in her own right. Portrait from the collection of James Stokely, and reprinted from the "Celestial Album" of Leon Barritt.

regarded as one of the eternally great names in scientific achievement, his success was built upon many decades of hopeful but fruitless yearning, which was finally replaced by planned research such as had never been undertaken before.

While still a boy he played in the band of the Hanoverian Guards and he spent his spare time studying. For more than a score of years his "spare time" was so spent—and this time often exceeded that given to his regular duties. When less than thirty he was appointed organist at Bath—a highly honored and fairly lucrative position. He was a teacher of music in addition to playing the organ, but at no time did he ignore his researches into physics, mathematics, optics and astronomy. He found it desirable to supplement his studies with actual observation. Telescopes were too expensive, so he started to build one for himself. He finished the first in 1774—when he was nearing forty. This was the first of a series of telescopes that were later turned out by the dozen. The mirrors were made of speculum metal. Herschel made scores of duplicate mirrors, so that, when one became tarnished, he simply substituted another, rather than take time to polish and refigure the surface. He enlisted the aid of his brother Alexander and his sister Caroline in his program.

The telescopes grew larger and more powerful, and were used in systematic observation. Herschel made a complete review of the heavens several times, to try to study every star that he could see. At the same time the concerts were continuing, and so were the music lessons.

Star brightness, colors, the distance and direction of the components of double stars—these were some of the studies which led up to one of Herschel's first great discoveries—that some of the pairs of stars were moving around each other. Here, in one discovery, Herschel proved that gravitation is truly universal—extending even to the immense distances of the stars.

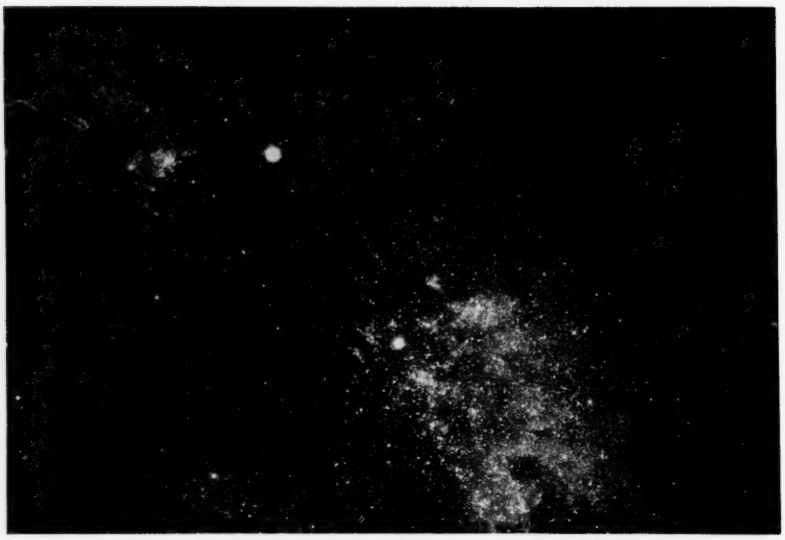
The periods of variable stars likewise came in for analysis. The characteristic of each object was absorbed by a mind which seemed to have no limit of retention.

When he was forty-three came the splendid discovery that was to startle the entire world. What at first appeared to be a comet turned out to be no comet at all, but rather a new planet—the first planet to have been discovered since the earliest days of mankind. Uranus was the first addition to the sun's family in the memory of men.

The news spread everywhere. The King appointed him his private astronomer, and star-gazing became a popular fad among the nobility. Herschel was, in truth, the man of the hour—then unquestionably the greatest of astronomers, just as he, even today, still ranks with the leaders of this profession. Even if Herschel had not discovered Uranus, he would still be remembered for his other scientific contributions to astronomy.

At about this time William Herschel finally gave up his music and devoted himself entirely to the heavens. He made and sold fine telescopes—among them the largest instruments that had ever been constructed. His four-foot mirror would still be regarded as a gigantic task. He found two moons of Saturn, two moons of Uranus, countless new stars and nebulae. He discovered that the sun and its family, are moving through space, by noticing the changing perspective of star groups. He studied how the stars were spaced, and developed the theory of a grindstone-shaped Galaxy.

His discoveries touched every field of astronomy. To Herschel, who earned popular and royal recognition during his lifetime, scientists of all time are indebted. He was the greatest astronomer of his day, and the greatest amateur astronomer of all time.



Deneb, jewel of the northern Milky Way, lies left and above center in this photo from the Ross atlas. One of the larger and nearer of the bright stars, Deneb pales into insignificance next to the greatest supergiants.

SIZING UP THE SUPERGIANTS

By Dora Russell

BEHOLD THE HEIGHT of the stars, how high they are!" says the Book of Job. But distance is not the only awe-inspiring thing about the stars. The sizes of some of them are also apt to make one gasp in amazement.

Stars not only look, by reason of their brightness, to be of different sizes—they are, very much so. Of course, you cannot trust your eyesight in such a matter, because of the tremendously varying distances. The brightest are not necessarily the biggest and, indeed, many of the larger stars are actually invisible.

The word "giant," which is applied to the biggest ones, is a very appropriate term, and is used in connection with certain classes of stars. But, although giants in size, they are really "babes in the galactic woods" —stars in their infancy. Their long span of life, numbering years by the millions in which they will slowly contract, lies ahead of them.

The stars belonging to the classification of "red giants" are of a tremendous girth. They are different from the usual run of stars—the strayed "black sheep" of the stellar family. And aside from their tremendous size, they have other peculiarities of their own.

The redness of the giants may perhaps suggest a high surface temperature. Far from being the case, these are the cold stars, if you can imagine there being such things. They belong to the spectral class M, in which stars are found whose temperatures at the surface range around 5,000 C. The orange stars have a somewhat higher temperature, the yellows higher stil, and the whites are white-hot. Compare the exceptionally low temperature of the supergiant Epsilon Aurigae, which is about 1700°C., with that of the companion star of Sirius, a very dense white dwarf with a temperature of nearly 15,000°C. and a diameter no larger than the planet Uranus.

Another peculiarity of the giant suns is their low density. The stars, as we all know, are made of gas—but gas under varying and "unearthly" pressures. This gas may be all bunched up tightly or it may be spread out thinly over a great area. In the first instance, the gas will be heavier and will have a high density. In the second instance it will be lighter, and its density will be low.

The densest of the stars are the white dwarfs, those tiny twinklers whose diameters measure only a few thousand miles across. The least dense are the supergiants, whose diameters are measured in the millions of miles, and whose material has thinned out to a remarkable degree. Antares is a good example of this. Our air is 3,000 times as dense as the material in this star. Both of these types are renegades from the straight and narrow path of stellar evolution.

In comparison with the extremely low densities of the giants, we have the extremely high ones of the white

A Newfoundland amateur and astronomical columnist discusses the vital statistics of some of the supergiant stars, and contrasts them with tiny white dwarf stars at the opposite end of the evolutionary line.

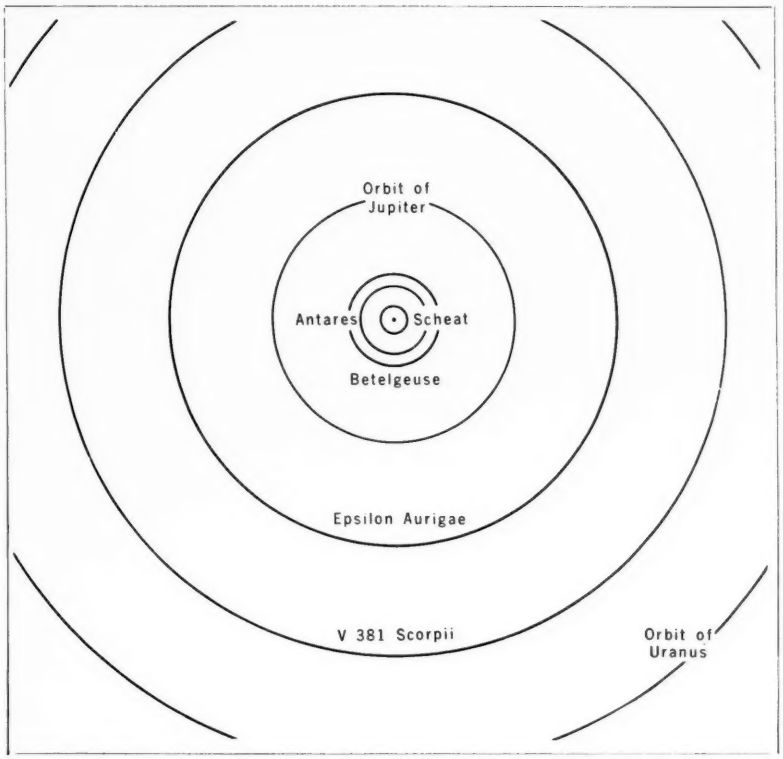
dwarfs. Van Maanen's little star, which is smaller than our earth, is yet so heavy that a thimbleful of its material would weigh 2½ tons. These white dwarfs are in the last stages of their stellar life. They have used up all their hydrogen, and when this happens, as it must eventually in the life of every star, the body of gas begins to contract. Naturally, as it contracts, it becomes more and more dense, until its great brilliance is lost to sight and the star passes into oblivion—a cold black lump.

The largest things we know in the universe are the supergiants. They are colossal in size, and include such stars as Mira, Betelgeuse, Antares, Ras Algethi, all of whose diameters are so huge that size, as we conceive it, becomes as meaningless as distance.

But how big is big? Stars are so far away that you see no size, even when you look through the most powerful telescope. They will appear only as sparkling points of light. To measure their diameters directly is quite out of the question, for there is simply no measurable diameter in optical telescopes, although several stars fall within the theoretical (but not actual) limits of resolution of the Mt. Palomar reflector.

There is, however, a very ingenious instrument, the interferometer, first applied to the 100-inch Mt. Wilson telescope in 1920, it has done excellent work in measuring these very small angles. The diameters of some of the larger stars have been ascertained in this way, among them Betelgeuse, Arcturus, Aldebaran, Capella, Deneb, Mira, Scheat, Antares, and Ras Algethi. The diameters of these stars, as shown by the interferometer, agree with those acquired by other, less direct, methods—a fact which must have been very heartening to astronomers.

First to enjoy the honor of being measured by interferometer was the star Betelgeuse, which blazes on the shoulder of superb Orion. Being a variable star, Betelgeuse varies considerably in size, and its diameter is periodically increasing and decreasing. Once the largest known, it has, in these more knowledgeable times, shrunk by comparison with other, even bigger, stars. Regardless, it is still of a very creditable size, and if the sun were to move over and let



The relative sizes of a few supergiant stars, with the diameters of the orbits of Jupiter and Uranus thrown in for comparison. V381 Scorpii, a variable for which tentative measurements have been calculated, indicates a maximum diameter of 3,000 solar diameters, making it the largest known stellar object. The small dot at center is the sun.

the giant variable takes its place, our earth would have plenty of room to travel its orbit inside the star!

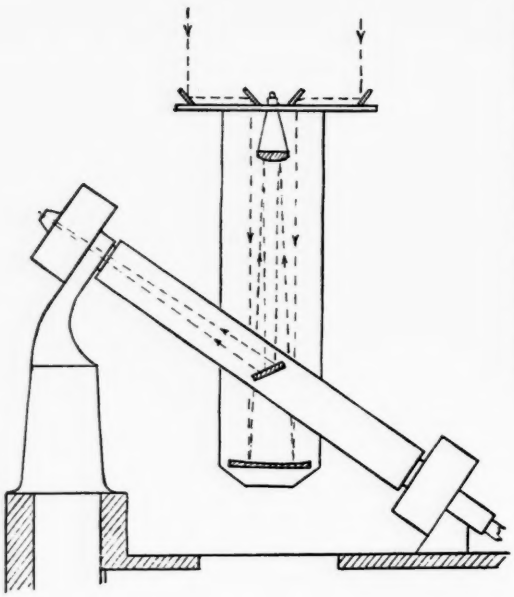
Mira, the splendid red variable in Cetus, is another big one. Like Betelgeuse, it varies in size, and is thought to be pulsating. Mira, the wonderful, is so huge that, if it were to take the sun's place in the heavens, our own earth would be tucked away deep in the interior of the star.

A typical supergiant is Antares, the red star in the heart of Scorpius. One of the few bright red stars in the sky, Antares, too, held for a time the honor of being the largest known star. It is still the largest of the first-magnitude stars.

Antares is a spectroscopic binary. In other words, the most powerful telescopes fail to separate it from its planetary companion, and it is only by means of the light-analyzing spectroscope that its existence has become known at all. Figures for its distance vary considerabe (500 light years plus) but there is no doubt, either, of the greatness of its diameter. The poet has found lovely phrases to describe the wondrous size of this great ruddy orb:

"This August night in a rife of cloud
Antares reddens,
The giant one, the ancient torch, a
lord among lost children,
The earth's orbit doubled would not
girdle his greatness, one fire
Globed, out of grasp of the mind
enormous."

But they come bigger, much bigger than this! For instance, the star that marks the head of Hercules (Ras Algethi) is so large that the relation of the earth to it in size is like the proverbial needle in the haystack. And what a haystack! The tremendous width of the star would encompass even the orbit of Jupiter,



The 20-foot interferometer attached to the 100-inch reflector at Mt. Wilson. Developed by Pease and Michelson in 1920, the two outer mirrors catch light from the edges of a large star. Two rays are then brought together at focus of mirror-system to point at which the light waves interfere with each other; separation of movable outer mirrors determines diameter of star within one percent. Reproduced from "History of the Telescope," Sky Publishing Corp.

fifth of the nine planets—a remarkably big star in a remarkable region of the sky, for here there are hardly two stars to be found moving uniformly. They all go their separate ways at different rates of speed and in different directions.

But the colossus of them all is a star in the constellation of Auriga. Epsilon Aurigae, an eclipsing variable, of the Algol type, has its diameter computed to be 2,000 times that of the sun, and some authorities prefer to quote 3,000 times as being more nearly accurate. This sun is so huge that you could almost put our entire planetary sustem inside it. Certainly it would enfold the orbits of the planets out as far as Saturn if it occupied the sun's position in the scheme of things. This would leave only Uranus, Neptune and little Pluto wandering about forlornly on the outside, wondering what fierce humour had seized their mother-star.

All of which leaves Epsilon Aurigae as the largest thing known to man. So far, no star has been found large enough to swallow up the entire solar system, but in time — who knows? As man's celestial yardsticks become more accurate and far-reaching, so do the dimensions of his earth-centered world continue to shrink.

New England Convention

The South Shore Astronomical Society in Massachusetts will sponsor a convention of amateurs from the New England area on Saturday, June 24th, at the Norwell Grange, Norwell, Mass. Amateur and professional exhibits, lectures, a home-style turkey dinner and a star party will be highpoints of the get-together. Convention committee member Thomas McDonald, Jr., hopes that this independent convention will become a regular event for amateurs in the northeastern states. Details on program and registration can be obtained from Miss Frances S. Winn, 74 Lincoln Ave., Wollaston 70, Mass.

League Northeast Meeting

Side-trips to Kodak Park and Bausch and Lomb will be highlights of the Northeast regional meeting of the Astronomical League at Rochester, N. Y., May 26-28. Meetings will be held at the Manger Hotel. Reservations and requests for information should be sent to Ralph K. Dakin, 720 Pittsford-Victor Road, Pittsford, N. Y. The three-day convention will be hosted by the Rochester Academy of Science.

WESTERN AMATEUR ASTRONOMERS TO MEET

THE AMATEUR'S Contribution to Astronomy" will be the theme of papers and discussions in the 1961 convention of the Western Amateur Astronomers, which is scheduled for Long Beach, Calif., on August 24-26. Western Amateur Astronomers chairman Tom Cave anticipates the presence on the program of a number of internationally known astronomers, owing to the proximity of the International Astronomical Union meetings in Berkeley. The IAU, the international body organized to coordinate international research and cooperation in astronomy, will end its 1961 meetings shortly before the beginning of the WAA sessions. The Association of Lunar and Planetary Observers will also hold joint sessions with the WAA during the convention.

Further details concerning the program and its amateur and professional participants will be published in the July-August issue. Interim information may be obtained from WAA secretary Mrs. Ruby L. Perkins, 4639 Vinita Ave., La Canada, Calif.

Field trips, star parties, exhibitions and a banquet will be among the fare provided at the Western Amateurs convention. The annual Bruce G. Blair award will be presented to Mr. Carl Wells of Roseville, Calif, at the convention banquet.

Mid-States Region

The Mid-States region of the Astronomical League will hold its annual meeting at the historic Morrison Observatory of Central College, Fayette, Mo., on June 16-18. A professional astronomer will address the amateurs at the convention banquet. Housing of guests will be at the college dormitories and all meals will be served at the campus cafeteria. Total costs for the three-day event will be $10.75, plus a $1.00 registration fee. Russell C. Maag, 211 Oak St., California, Mo., is convention chairman.

The 12-inch refractor at the Morrison Observatory is expected to be reconditioned in time for the convention. The great red spot of Jupiter was first observed with this intrument on July 9, 1878, by Dr. Henry S. Pritchett.

Dr. H. P. Wilkins, late British lunar observer, was featured speaker at 1954 "Eclipse" convention of Astronomical League in Madison, Wis. At Wilkin's left is his daughter and Tom Cave, chairman of Western Amateur Astronomers, who will also meet in convention later this summer (p. 8).

LEAGUE-ALPO CONVENTION JULY 1-3

BY MID-APRIL advance reservations for the 1961 Astronomical League convention in Detroit were already rolling in, according to publicity chairman Joseph Maple. This 15th annual general meeting of the League will officially open on July 1st and close with the afternoon session on Monday, July 3rd. Also convening in conjunction with the League will be Association of Lunar and Planetary Observers, members of which will hold a meeting and paper session during the convention.

Commercial and organizational exhibits will also be a feature of this year's convention. Individuals and groups with material for exhibition are invited to contact exhibit chairman Edward Fifield, 19376 Montrose, Detroit 35, and advise him of the nature of their exhibits and their requirements. Persons desiring program time (see schedule) should send their requests to convention vice-chairman E. C. Balch, 96 Farrand, Highland Park 3, Mich.

Information concerning accommodations and registration may be directed to John Manquen, 1838 Catalpa, Berkely, Mich., but room reservations should be made directly with the Hotel Henrose, Detroit 26, Mich. Specify the Astronomical League convention in writing, since a block of rooms is being reserved at special rates.

As mentioned in the March-April issue, a trip to the nearby University of Michigan Observatory at Portage Lake, Mich., will be a highlight of the three-day meeting. Other features will be talks by Dr. Fred T. Haddock, director of Michigan's radio astronomy project, and Dr. Helen S. Hogg of the David Dunlap Observatory in Toronto. Dr. Hogg is recognized as an authority on star clusters.

The Astronomical League convention is open to any interested amateur, and offers amateurs an opportunity to meet others of similar interests and to exchange ideas. General chairman of the 1961 convention is C. D. Marshall. The Detroit Astronomical Society will act as hosts. President of the Astronomical League is Norman Dalke, Seattle, Wash.

NORTHWEST AMATEURS TO MEET IN JUNE

The Northwest region of the Astronomical League will hold its annual meeting on the campus of Wenatchee Valley College, Wenatchee, Wash., on June 17-18. Exhibits and a star party, as well as business and paper sessions, will be features of the convention program. Amateurs interested in attending should contact convention chairman C. R. Goodman, 1230 Brown St., Wenatchee, Wash., for information on reservations.

PROGRAM SCHEDULE
DETROIT ASTRONOMICAL LEAGUE CONVENTION

Friday, June 30	
1:30 p.m.- 5:30 p.m.	Registration
7:00 p.m.- 9:00 p.m.	Social Hour
Saturday, July 1	
9:00 a.m.-10:00 a.m.	Registration
10:00 a.m.-11:30 a.m.	Opening Session
11:30 a.m.-12:00	Professor Haddock, U. of Michigan
12:00 - 1:00 p.m.	Lunch
1:00 p.m.- 6:00 p.m.	Field Trip
7:30 p.m.- 8:30 p.m.	Great Lakes Region—Annual Meeting
8:30 p.m.	Council Meeting
Sunday, July 2	
9:30 a.m.-12:30 p.m.	ALPO Convention
12:30 p.m.- 1:30 p.m.	Lunch
1:30 p.m.- 2:30 p.m.	Dr. Helen Sawyer Hogg
2:30 p.m.- 4:00 p.m.	Papers
4:00 p.m.- 5:00 p.m.	Group Photograph
7:30 p.m.	Honor Dinner
Post-Banquet—Council Meeting	
Monday, July 3	
9:30 a.m.-12:00	Papers: Junior, Instrument Section, and General
12:00 - 1:30 p.m.	Lunch
1:30 p.m.- 3:30 p.m.	Papers
3:30 p.m.- 3:45 p.m.	Summary—General Chairman
3:45 p.m.	Business and Election of Officers
7:30 p.m.	Council Meeting

The Skies for May - June

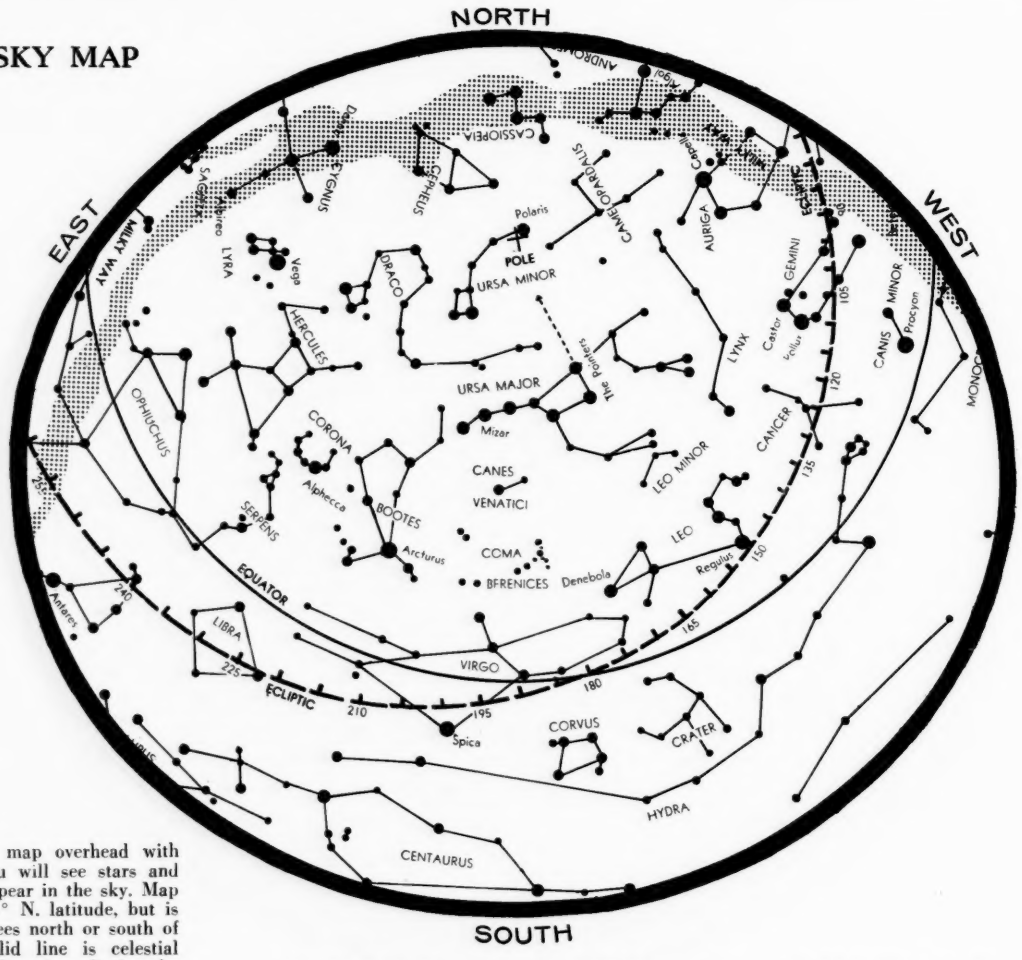
AS DARKNESS FINALLY ARRIVES during the months of May and June —delayed a bit by natural and (in many areas) unnatural forces—it carries within its cloak some of the sky's most prominent and interesting star groups. Ursa Major is directly overhead, a celestial centerpiece highlighting the appetizing fare of spring constellations that is spread before us.

The graceful curve of the Dipper's handle leads our eyes to orangish Arcturus, which is nearly overhead after dark in mid-May. Although Vega is thought by many observers to be the brightest star in the spring and summer skies, astronomers have now placed Arcturus more than half a magnitude brighter than Vega; however, the later's bluish hue gives it a stronger hold on the retina of the eye. Arcturus lies at the south end of the constellations of Bootes (Boe-uh-teez), which resembles an elongated kite and is a prominent zenith group at this time of year.

To the west of Arcturus, and south of the tip star in the handle of the Dipper, lies the tangle of stars known as Berenice's Hair, or Coma Berenices. This ill-defined clump of fourth- and fifth-magnitude stars springs into life in field-glasses, although its position at the zenith in May suggests that the observer assume a reclining position. Dew and all, the sight is well worth the effort of viewing it at leisure.

Just to the west of Bootes rides Corona Borealis, the Northern Crown, a fairly bright circlet of stars with the lovely star Gemma (Alpha) as its fairest gem. Within the Northern Crown lies another treasure for binoculars, the erratic variable star designated as R. It can be located by referring to the equatorial charts in this issue as a small circle within the confines of the little asterism and just north of Delta. Usually found at sixth-magnitude, and nestled near to a seventh-magnitude star, it will suddenly begin to fade three to six magnitudes in a short period of time. R Coronae frequently remains at minimum for a long period of time, but occasionally will regain its original brightness quickly. You should become familiar with this little star in your evening sky-checks—you may catch it in the middle of its drop to minimum.

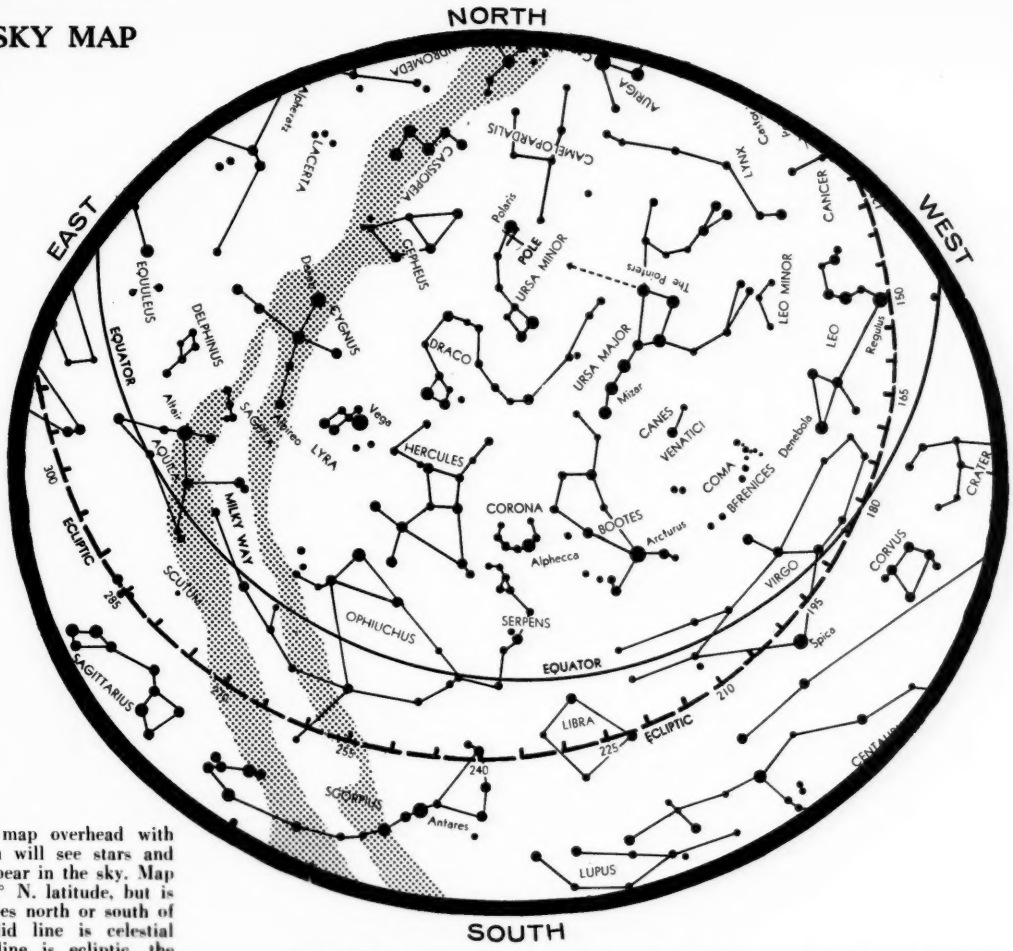
EVENING SKY MAP FOR MAY



Face south, hold map overhead with north at top. You will see stars and planets as they appear in the sky. Map is designed for 40° N. latitude, but is practical ten degrees north or south of that latitude. Solid line is celestial equator; dashed line is ecliptic, the apparent path of sun and planets.

10:00 P.M., May 1 **9:00 P.M., May 15** **8:00 P.M., May 31**

EVENING SKY MAP FOR JUNE



Face south, hold map overhead with north at top. You will see stars and planets as they appear in the sky. Map is designed for 40° N. latitude, but is practical ten degrees north or south of that latitude. Solid line is celestial equator; dashed line is ecliptic, the apparent path of sun and planets.

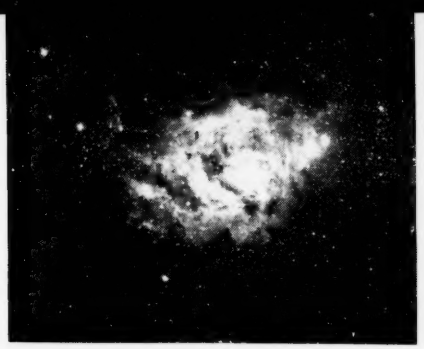
10:00 P.M., June 1 9:00 P.M., June 15 8:00 P.M., June 30

The regions of the sky south of Arcturus in May and June are not too impressive to the naked eye, but you can scarcely call yourself a card-carrying constellationist until you know such groups as Virgo, Libra and Hydra. For the brighter stars in these groups, we suggest that you refer to the equatorial charts in this issue.

For some reason, the winding circumpolar constellation of Draco, the Dragon, is not as well known as it should be. Perhaps this is partly due to the rather faint stars which constitute its sinuous trail through the northern skies, but we think it is also a matter of scale. We are used to finding our star groups tightly compacted, but if we can just enlarge our gaze to include a spread of some 45° in the sky, Draco soon becomes a familiar object. Starting at its tail, which lies between the Pointers and Polaris, Draco winds westward between the two Dippers, then humps northward near its neck and ends in a quadrilateral head, which is poised menacingly above and to the north of the fearless Hercules.

Not only is Hercules indomitable in his heavenly domain, he is also a splendid constellation full of telescopic objects. One of these objects can be located with the naked eye on a clear, dark evening. First it is necessary to locate the most conspicuous feature of Hercules, the "Keystone" that marks his mid-section. This is a four-side figure, from which stretch the arms and legs of mighty Hercules. At the western edge of this Keystone, on a line between the two stars and about one-third of the way down toward the more southerly star, can be found the great globular star cluster designated M13 in Messier's catalogue. The Hercules cluster gives no hint of its stellar nature to the naked eye or to the field-glass, looking very much like a faint naked-eye comet or a fuzzy star. A telescope, however, quickly begins to resolve this clump of stars, which lies some 34,000 light-years distant from our solar system. It's a "long, long look" you get when you spot the Hercules cluster unaided!

Naturally, we'll all want to take a last look at the star groups which are passing into temporary oblivion in the west—Leo, Gemini, Auriga and the others that heralded the early spring season that many of never had a chance to experience in this odd and unfriendly first quarter of 1961. Clear skies, dark and warm, to all until the next issue.



The Lagoon Nebula (M8). This naked-eye nebula lies near the center of the Galaxy, a rewarding object in any instrument. Many stars are visible against its milky whiteness. Lick Observatory photograph.

A HEAD START ON SUMMER CLUSTERS

IT WAS JUST 25 years ago that this writer—as a very young man—had his first view of the Milky Way . . . the drama of the Galaxy suddenly rolled out on a black carpet and unfolded before him. It was from the hatch of a freight steamer in the Caribbean, several hours out of Martinique and bound for Trinidad after a voyage of several days along the fringes of a tropical hurricane. The saloon was warm and smoky, the hour was late, and the boy was a bit tired and bored with the adult fare below. The deck was cool, quiet and dark, and there were no other passengers to take their nightly constitutionals around the deck.

The St. Pierre light had almost faded from view now—the 6x35 binoculars barely kept its winking in view. Suddenly, it seemed quite natural to stretch out on the canvas-covered hatch and watch the lights above. But such lights—the zenith seemed to explode with the great clumping of star masses it held. Massive forms, hazily outlined on the memory, now loomed high and bright, full of brilliant patches and packed with fire. It was the Milky Way on fire—and a touch of the binoculars immediately broke the tight jam of stars into fragile and mysterious pieces, each one holding its own personal magic. It was on that night that the boy became an amateur of astronomy.

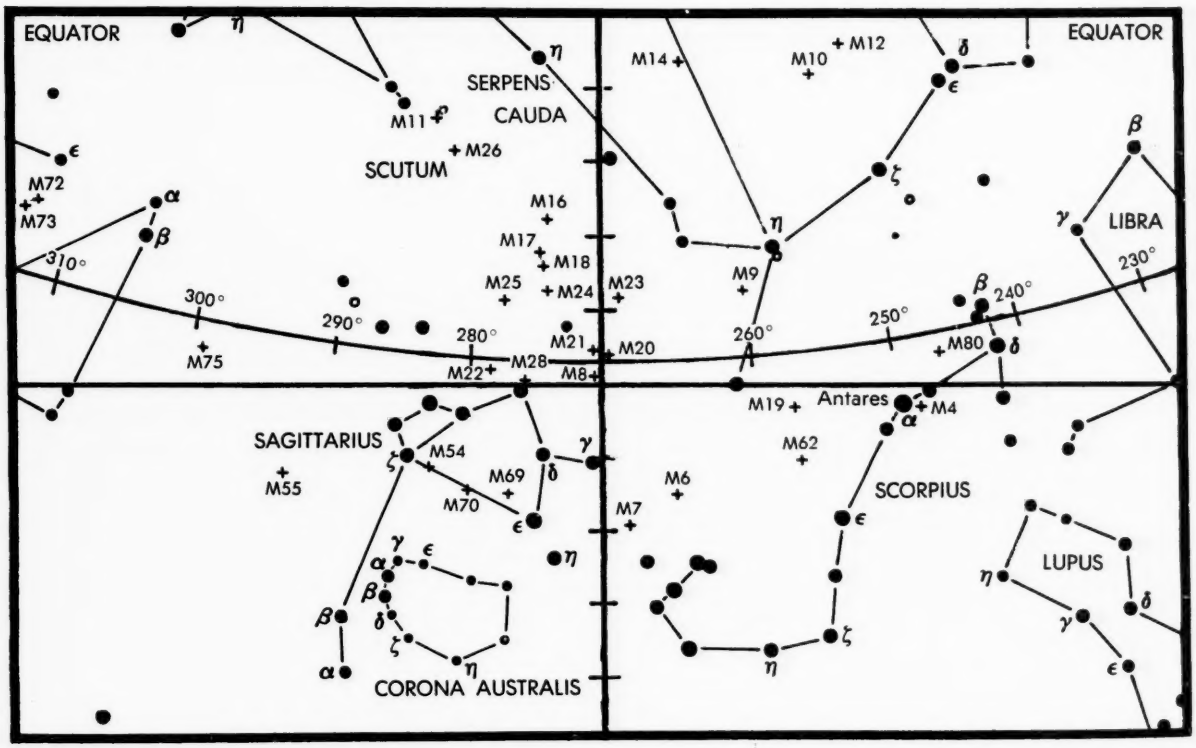
Now—the Milky Way seen from southern climes, aboard a ship at sea in the quick black tropical night, is an experience not regularly available to many of us. But the heart of the Galaxy is with us up here, a bit low

(LEFT)

Area between the Scutum star-cloud (upper left) and the Sagittarius cloud (lower right)—one of the richest regions in the heavens. M11 rests in bay at top of Scutum cloud, the northernmost of a string of galactic objects which stretches down into Sagittarius and the hub of the Milky Way Galaxy. Reproduced from Ross-Calvert "Atlas of the Northern Milky Way."

(BELOW)

The chart below shows the location of all of the Messier objects of interest in the area of the galactic center. Region from M11 on chart down to M20 can be used to identify objects in photograph on the opposite page.



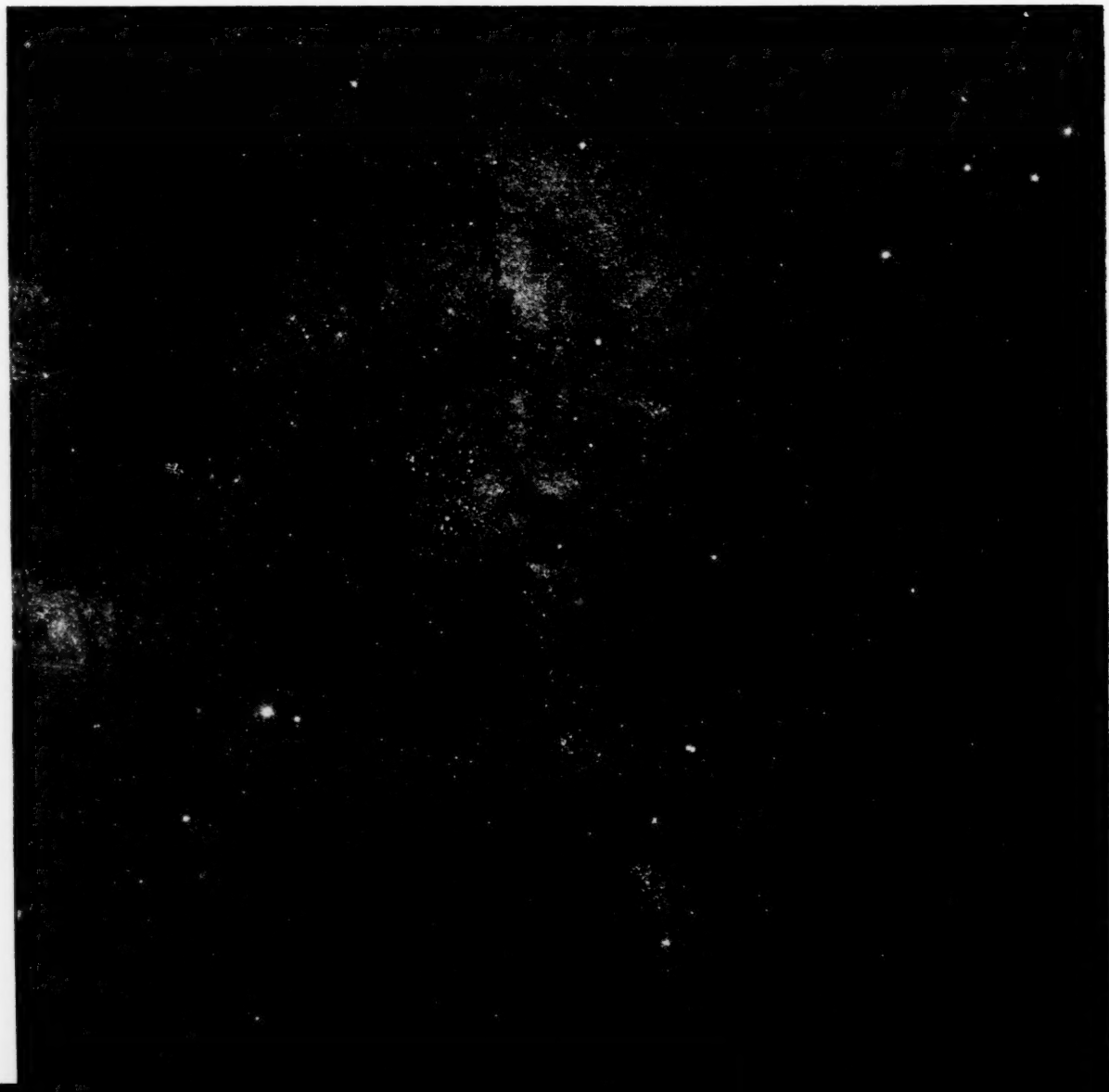
and slightly diminished, especially in urban areas, but still full of enticements for a modest telescope or binoculars. The Milky Way, as it appears in Sagittarius, Scorpius and Ophiuchus, is still the happiest of hunting grounds for a small telescope in summer—and there is absolutely no reason to hang around waiting for July or August. By midnight in May or June the southern reaches of the Milky Way in Ophiuchus, and a bit later in Sagittarius, are well in view —so why not now?

If you live in the city, or even in the suburbs, it's worth your while to jump in the car and make a trip south of the city lights. Small telescopes make this a comparatively simple move, and you won't need anything more than a few inches of aperture and your lower range of powers. The chart at the bottom of page 13 can guide you if you haven't a full-fledged atlas—it shows the objects that the comet-hunter Messier encountered and catalogued nearly two centuries ago, and includes most of the prominent galactic objects that crowd the skies in that area. Each is designated with its Messier (M) number for easy reference.

The accompanying photographs will assist you in relating the chart to what you see in the heavens. We won't spend long paragraphs in descriptions; a few comments will suffice, because the objects speak for themselves through the eyepiece of your telescope or binocular. Actually, binoculars are invaluable in locating the Milky Way clusters and star fields, and they will afford glimpses similar to those shown in the photographs—although you will not suffer the "burnout" of overexposure, and the clustering of stars will separate into delicate pinpoints of light.

Deneb and Vega form the base angles of a long, south-pointing triangle with the bright Altair at its apex. The constellation of Aquila itself points downward to the southwest, as if bringing your eye to the lovely jewel which nestles in the Scutum starcloud—M11. M11 is a small but bright galactic cluster, fan-shaped and with a conspicuous little star at its apex. Then, after scanning the area to its south, the chart and large Ross *Atlas* photo opposite it will guide you down — toward the heart of the Galaxy.

M26 is another open cluster, several magnitudes fainter than M11's 6.0; it is on the edge of one of the dark rifts that interested the great observer and photographer Barnard.



Perhaps its real apparent brightness is diminished by the obscuring matter. But, there is more.

In Serpens, which encircles the waist of Ophiuchus, there is M16, almost lost among the stars at 10th magnitude and 8′ of arc diameter; and a bit to the south across the border into Sagittarius is M17, the Omega, or Horseshoe, nebula. So named because of its shape, you will more likely see it as a "2"-shaped object nearly half a degree in diameter. Its shape is ill-defined due to overexposure on the Ross plate on page 12.

M18 is small but bright (7.5), hanging delicately below the Horseshoe nebula. To its west is M23, a rather faint but relatively close open cluster of some 120 suns. To the east of M24 is M25 (an orderly fellow, this Messier), which also appears on the chart for the minor planet Iris on page 18 in this issue; the asteroid passes just south of this loose, sprawling galactic cluster. But you will fare even better farther south, at the north end of the great Sagittarius starcloud, which is adorned with the large and interesting Trifid nebula (M20).

But our real game is still to the south a degree or so. We can spot this easily with the naked eye—in binoculars it beckons even more, and on telescopic observation we are still squinting and wondering. This is the Lagoon nebula—M8—illustrated in the Lick photograph at the beginning of this article. Nearly a degree in length, this elongated galactic nebula bears careful attention. The Rev.

The lower part of Scorpius is shown in this photograph from the Ross "Atlas of the Northern Milky Way" (University of Chicago). Antares, photographically diminished in brightness on this plate, lies at lower left in the circlet of stars in upper right corner. "Star" to its right is cluster M4. Body and tail of the Scorpion extend down to lower left—M6 and M7 are just above the last star in the stinger.

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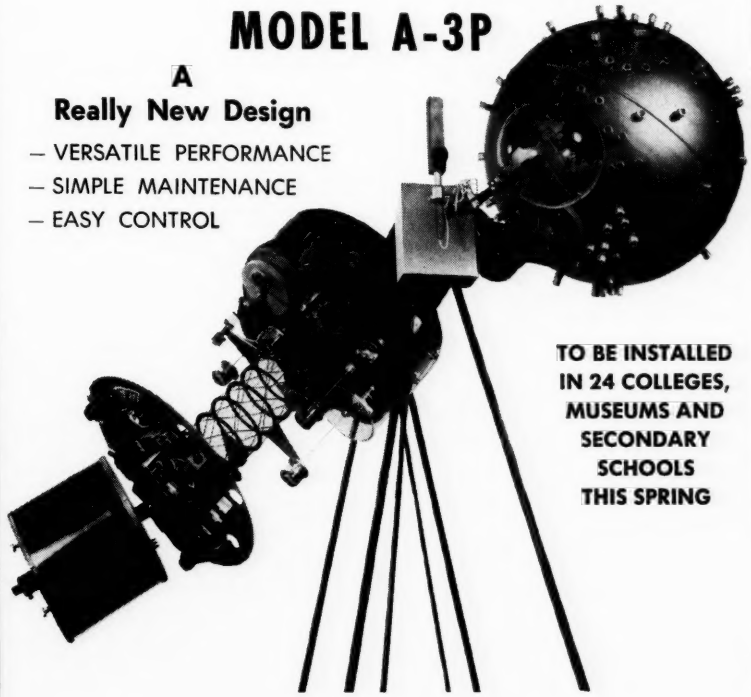

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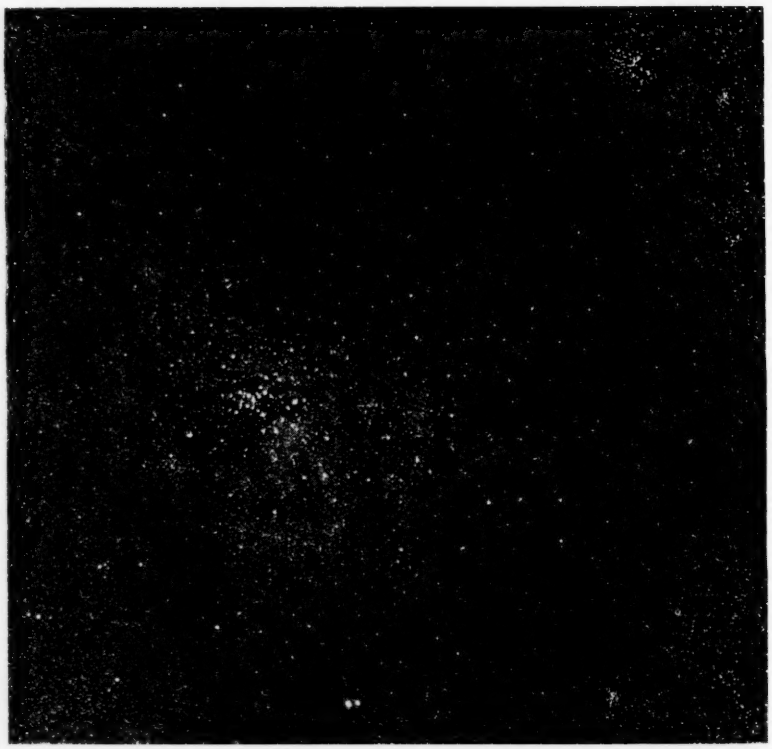

Clusters M7 (left center) and M6 (upper right) are visible in this photograph made by Barnard for his "Atlas of Selected Regions of the Milky Way," Carnegie Institution, Washington, 1927, M7 is conspicuous against the background of fainter Milky Way stars.

Webb, in his *Celestial Objects for Common Telescopes* (coming back into print as a paperback!), comments: "Splendid Galaxy object . . . in a large field we find a bright, coarse triple star, followed by a resolvable luminous mass . . . and then by a loose bright cluster enclosed by several stars; a very fine combination."

If the skies are dark, you will see a fuzzy star directly east of the Lagoon nebula. Aside from M13 in Hercules, this is the only northern globular cluster visible to the naked eye—M22. It has been pointed out that the brighter stars in this cluster are red—possibly due to the interstellar absorbing matter that hides most of the globulars from view in

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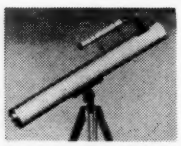

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the "zone of avoidance" along the plane of the Galaxy. The stars are faint in the 3-inch, however, and you won't be able to separate them. Trumpler marks its combined magnitude at 3.6—Shapley its distance at some 22,000 light years; near the center of the Galaxy.

There are more objects in the Sagittarius region; you will never run out of telescopic targets. If you feel you are, though, just revert to binoculars and start over — it's another world on another scale. But onward—Scorpius offers a bit fewer but equally attractive subjects for telescopic quests—and located in less congested fields. The two photographs accompanying this article are indications of what you might expect—M80, the bright globular north of Antares; M4 to the east, a galactic cluster; and the twin open clusters near the Scorpion's stinger, M6 and M7, the former being a naked-eye object.

Ophiuchus offers further adventures—the entire region abounds in telescopic objects piled one on another. So try the coolish late spring nights—transparency is often better than in the muggy air of midsummer. Regardless. the southern Milky Way is an exciting adventure. You will never tire of it—and your little 3-inch can make the trip more than worthwhile. You will go back again.

D.D.Z.

★ ★ ★

MINOR PLANET NOTES

THERE WILL be four asteroids brighter than 11.0 coming to opposition during May and June. Beginning asteroid hunters will have some fun spotting them by night-to-night motion against the star background—all of them are located in the southern Milky Way. This, of course, is to be expected, since the Minor Planet Center at the Cincinnati Observatory only issues the predictions for the six weeks around opposition, when the minor planets are at their brightest. As a result, the asteroids are on the meridian at midnight, and are the fleeting captive of any zodiacal constellation in their way. May and June find the southern Milky Way directly south at this time of night. Not only are the star fields jammed with stars, but the ecliptic, whose confines the asteroids observe a bit grudgingly, reaches its southernmost declination in Sagittarius. This serves to add low-angle viewing and its resulting problems to the cluttered field of view.

Nevertheless, this is a good time to get in practice, for the last half of 1961 will bring the "Big Four" asteroids—Pallas, Ceres, Vesta and Juno into brighter and more convenient apparitions. A chart of the asteroid 7 Iris, which has the brightest opposition magnitude (9.9) during this period, is printed on page 18 for the convenience of observers without detailed charts. We will continue to print charts of the brighter and more interesting minor planets, but we suggest that interested amateurs procure one of the more detailed charts available today. Among these are the *Atlas Eclipticalis* (Sky Publishing Corp.), Webb's *Atlas*, the Beyer-Graff *Sternatlas*, or if the

(Continued on page 18)

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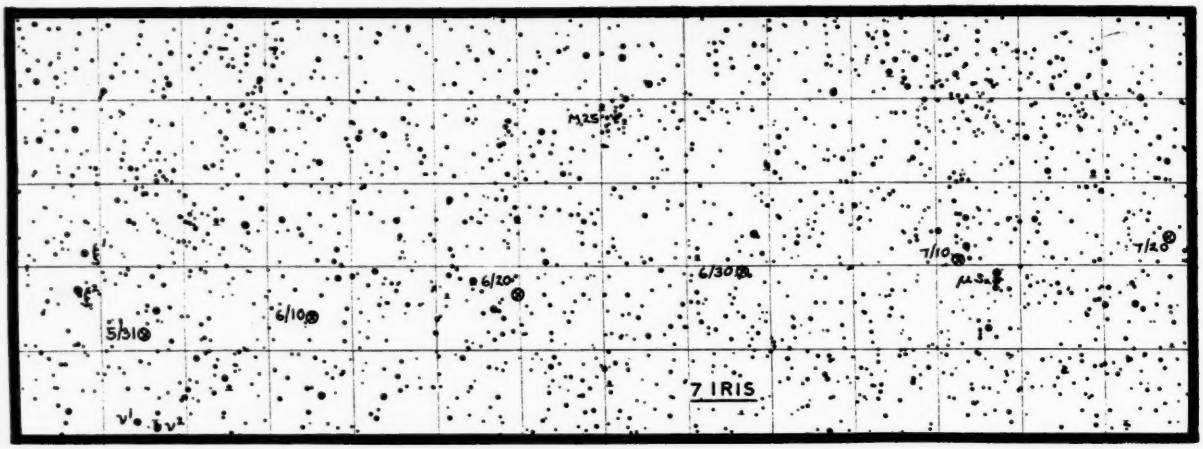

Asteroid Iris during opposition. Chart area is in Sagittarius; north is at the top. Brightest stars are 4th magnitude, faintest 10th. Chart adapted from "Bonner Durchmusterung."

(Continued from page 17)

budget is willing, the complete *Bonner Durchmusterung*. (These latter are available from Herbert Luft.)

The following ephemerides, or predictions of positions, include the number and name of the asteroid, the date of opposition, and the approximate magnitude at that time. Positions in right ascension and declination (1961) are given for ten-day periods around opposition. These positions are for 0^h Universal time (7:00 p.m. EST—five hours earlier), so you will have to allow for this differential when observing in late evening or early morning hours. Motions of the asteroids at opposition will be westward (retrograde) in all cases.

BRIGHT MINOR PLANETS
May-June 1961

Date (Oh UT)	RA h m	Dec ° ′
10 Hygeia 5/15 10m0		
4 21	15 44.5	−24 34
5 1	15 38.0	−24 14
11	15 30.3	−23 44
21	15 22.1	−23 06
31	15 14.5	−22 25
6 10	15 07.5	−21 45
25 Phocaea 6/3 10m4		
5 11	17 00.3	−24 34
21	16 54.4	+00 45
31	16 46.5	+ 3 56
6 10	16 37.8	+ 6 37
20	16 30.0	+ 8 32
30	16 24.2	+ 9 39
7 Iris 6/25 9m9		
5 31	18 40.1	−21 50
6 10	18 32.0	−21 36
20	18 22.1	−21 22
30	18 11.3	−21 06
7 10	18 00.8	−20 50
20	17 51.7	−20 36
29 Amphitrite 6/2 10m5		
6 10	19 06.4	−32 00
20	18 57.9	−32 25
30	18 47.5	−32 41
7 10	18 36.7	−32 43
20	18 26.7	−32 33
30	18 18.5	−32 13

(Ephemerides courtesy of Cincinnati Observatory Minor Planet Center.)

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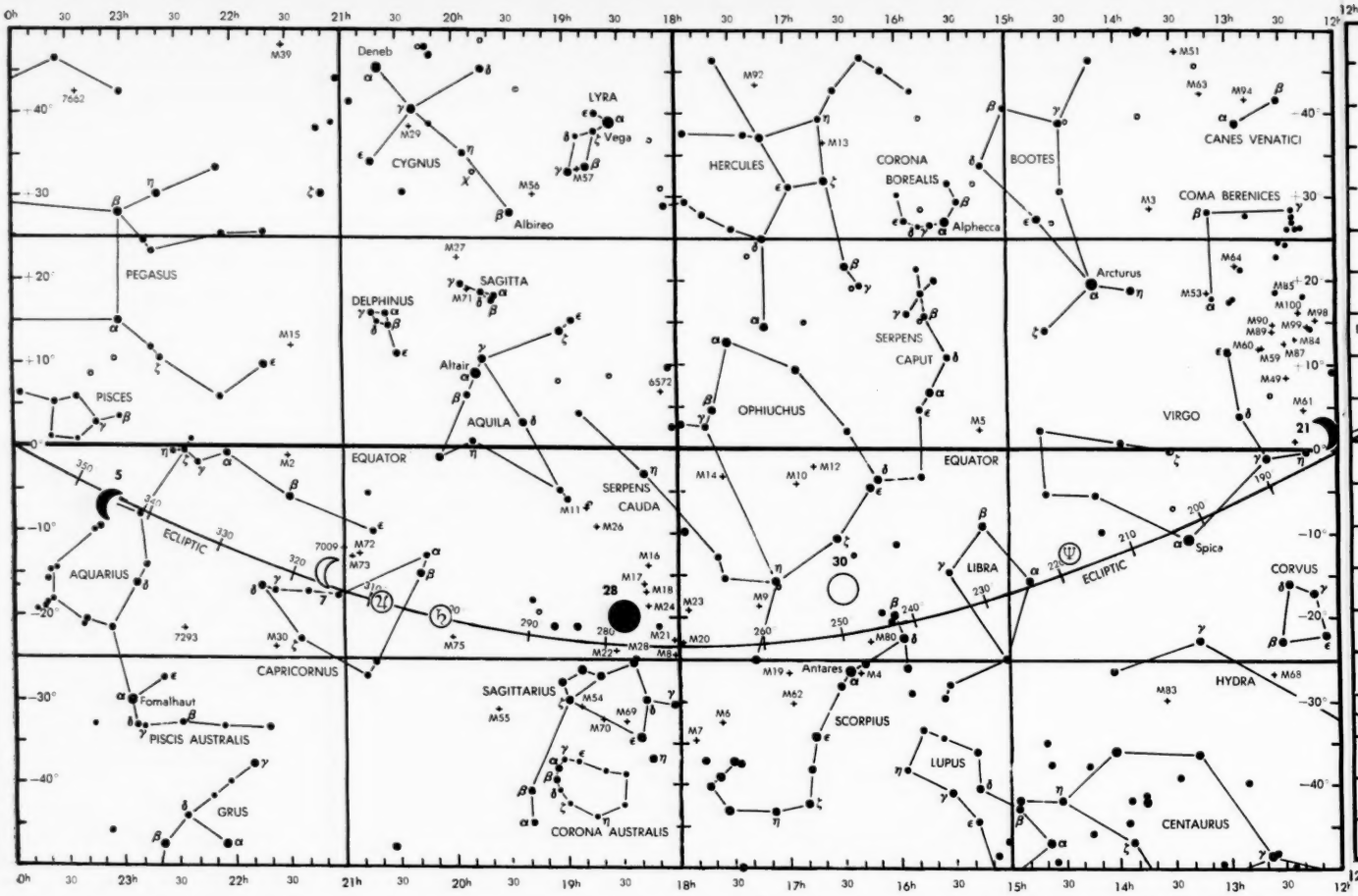


The charts on these pages show the star field from the equator to 50° south and 50° north. Right ascension is measured from west to east in hours; each notch at the top and bottom of the charts represents 10m of right ascension. Declination is measured to the north and south of the equator in degrees plus or minus; each notch at the right and left of the chart represents 5° of declination. Longitude along ecliptic is measured in 10° segments.

EQUATORIAL SKY MAP

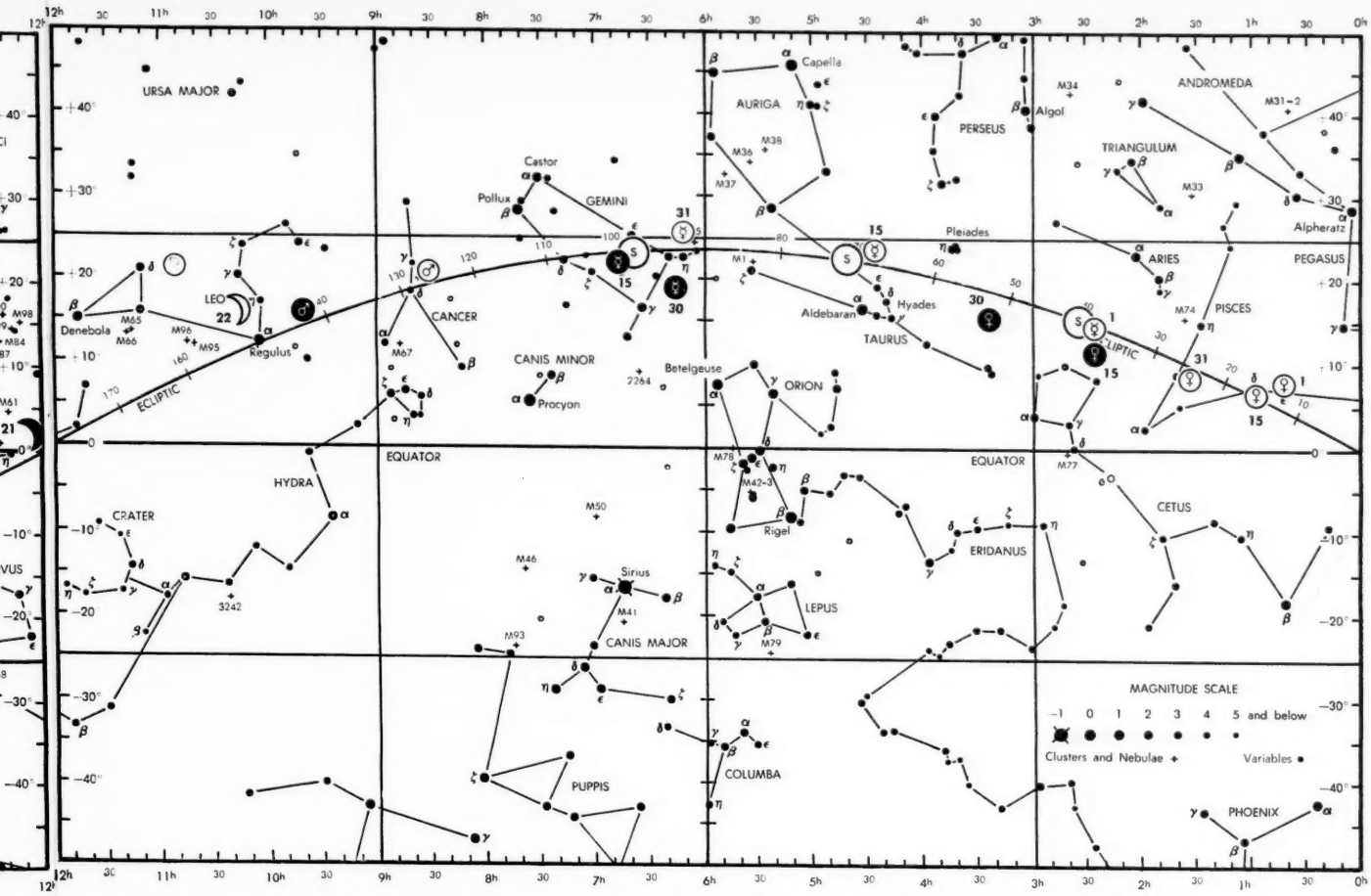
MAY AND JUNE AMONG THE PLANETS

SUN: Beginning May in mid-Aries, the sun will enter Taurus on the 15th. Its journey through Taurus will be completed on June 20th when it enters Gemini. One more day will bring the sun to its most northern point, the summer solstice, and astronomical summer will begin. The nights are the shortest of the year, with twilight cutting deeply into the evening and morning hours and seriously limiting the observing time of northern hemisphere astronomers, professional and amateur. Amateurs living in areas "cursed" with daylight saving time find that night really begins at bedtime, turning night into day.

THE MOON: Last quarter of the moon comes on May 7th, full moon on the 14th, on the 22nd is first quarter and full moon occurs on the 30th. In June, the phases are: last quarter on the 5th, new moon on the 13th, on the 21st will be last quarter, and full moon on the 30th. Noting the dates and times for the moon's phases in the *Sky Watchers Diary* and applying some simple arithmetic, one can see that the moon does in fact obey the Keplerian "equal areas" law of planetary motion. The new moon comes on May 14.5 (using the decimal equivalent of the hours) and first quarter on May 22.5, or 8.0 days. From full moon on May 30.0 to last quarter on June 5.7 is only 6.7 days. This difference is due largely to the variable motion of the moon in its orbit through apogee on May 21st, when it is farther than average distance away, and through perigee on June 1st, when it is nearest the earth. The moon moves slowest through the first period and fastest through the second, or shorter, period of time.

MERCURY: A favorable eastern elongation of Mercury occurs on May 31st (23°), when it will be seen in the evening after sunset for a few days before and after that date. See Heliocentric Planet Charts for circumstances. Mercury will be in superior conjunction on May 1st. It will draw in toward the sun during June, and on the 27th will be in inferior conjunction.

VENUS: Greatest brilliancy of Venus will occure on May 16th when it will be seen in all its luster in the east before sunrise. It will move farther from the sun until greatest elongation west is reached on June 19th (46°). On May 15 Venus will cross



Planets are indicated by standard symbols (see key). White circles for first month; black circles for second month. Moon plotted for exact time of phase (new moon omitted). Mercury and Venus are shown for first, middle and end of months; Mars for middle of month; other planets for mean positions during the two-month period. Sun is shown for first of each month.

KEY TO PLANET SYMBOLS

Mercury	☿	Saturn	♄	First Q. Moon	☽
Venus	♀	Uranus	♅	Full Moon	○
Mars	♂	Neptune	♆	Last Q. Moon	☾
Jupiter	♃	Pluto	P	Sun	☉

the descending node and pass to the south side of the ecliptic.

MARS: The earth is now pulling away from Mars at a rapid pace, increasing its distance from 146 million miles on May 1st to 191 million miles on June 30th. Mars will fade from first magnitude to second magnitude in the middle of the May, that is, from magnitude 1.3 to 1.8. It will not be a very prominent object in the western evening sky. Its small disc wil appear unimpressive in the telescope. Mars will be in aphelion (greatest distance from the sun) on May 5th.

JUPITER: This giant of planets will move slowly eastward through Capricornus in early May, becoming stationary on the 26th, when it will begin to retrograde. This change of direction should be of some interest to watch, as well as the relative positions of this and the next planet, Saturn, which will be found nearby. The stellar magnitude of Jupiter will increase a few tenths of a magnitude to −2.3 by the end of June. At the beginning of May Jupiter rises at about 2:00 a.m. (local daylight time), at 10:00 by the end of June.

SATURN: The performance of Saturn during May and June will resemble that of Jupiter, its neighbor in Capricornus, but will be slower and less obvious than its brighter neighbor. Saturn will become stationary on May 9th and thereafter it will reverse its motion to westward in direction. Using the new Heliocentric Planet Charts, one can trace the real and apparent motions of Saturn and Jupiter and gain insight into the details of planetary motions.

URANUS: The one planet not known to the ancient world which can be discerned by the unaided eye is Uranus, discovered by Sir William Herschel in 1781, with a telescope probably inferior to many amateur telescopes of today. On May 1st, this planet will begin its eastward motion after having retrograded since the beginning of the year. It is now located in Leo west of the "sickle." It will be too low in the west during most of June to be observed easily.

NEPTUNE: Eighth magnitude Neptune is in Libra, close to the Virgo boundary, where it may be observed with optical aid. It will be in RA 14h 29m, Dec. −12° 49′ on June 1st.

PLUTO: Very faint, Pluto can not be observed with most amateur telescopes. It is in Leo, moving very slowly, and at a considerable distance north of the ecliptic.

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BOOK REVIEW

TELESCOPES

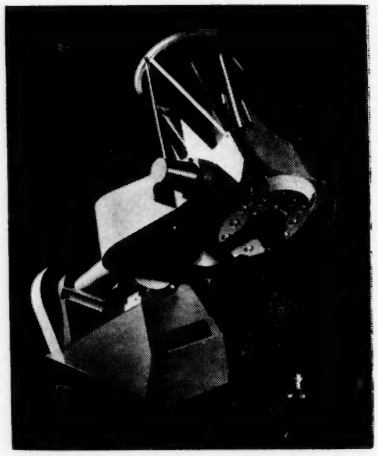
(University of Chicago Press, 1960; edited by Gerard P. Kuiper and Barbara M. Middlehurst; 255 pp., $8.50.)

By Robert E. Cox

Volume one—Telescopes of the series Stars and Stellar Systems (the total number of subjects eventually to reach nine) covers the field of scientific observing instruments from the professional astronomer's point of view, but contains much of interest to the amateur telescope maker and observer. Fourteen experts have collaborated in the discussion of types of instruments and their mountings—both optical and radio; clock drives; atmospheric seeing conditions and selection of observatory sites; new materials for telescope optics; and special instruments for time and positional astronomy measurements.

The twelve chapters are well divided in the selection of material. The first two deal with optical, mechanical and operational details of the two largest reflectors in the world, the 200-inch Hale and the 120-inch Lick instrument. Excellent photographs and drawings will reveal to the reader many facts about these telescopes; he will be intrigued and amazed at the cleverness and accuracy with which the engineers have been able to fabricate these monstrous mountings.

Chapter three covers the design of large reflecting telescopes, particularly the 36-inch and 84-inch of the new National Observatory being erected at Kitt Peak in Arizona, and well illustrates how modern scientific methods are improving the mountings and optical design of astronomical instruments. Of special interest to telescope makers is the section on mirror materials discussing Pyrex, fused quartz, and pyroceram (the nose cones of our ICBM missiles are constructed of one form of this material). At one time Corning Glass Works was considering the marketing of Pyroceram mirror disks for the amateur, and the writer has an optical flat constructed from one of the early experimental blanks. Unfortunately, early this year Corning decided against producing this material and instead is recommending their fused silica for mirrors.



Scale model of the 84-inch reflector under construction for the National Observatory at Kitt Peak, Arizona. The new instrument incorporates all latest optical and mechanical techniques, and is discussed in detail in "Telescopes." National Science Foundation photograph.

It was with considerable interest that a special section of chapter three on metal-mirror materials was studied. The materials investigated and reported upon were beryllium—although promising, its toxic nature limited experimentation; titanium—poor reflectivity and considerable scattered light from a too porous surface; aluminum alloys—good dimensional stability—and with an oxide-coated surface, Al_2O_3; sapphire—a polish can be obtained with diamond powders, but porosity of the surface is still a problem; and kanogen, a metal coating of nickel-phosphorus composition. This is the most promising of all materials; it adheres with great tenacity to a softer metal base and takes a high polish without the porous difficulties of the other metals.

Camera enthusiasts will find chapter four excellent for its concise treatment of the Schmidt camera and analysis of its aberrations. If the reader takes the time to go through the 40 formulas associated with the contents of this section he will have a good thorough understanding of the limiting factors in the operation of this type of camera.

Clock drives for telescopes are important accessories, and the serious observer and telescope maker will find the discussion on their design and operation in chapter five a fund of ideas. Although large observatory

instruments are discussed, the principles outlined have general application to the serious and mechanically minded amateur. The design of gravity, electric motor, and electronically controlled drives is covered in the materials, with an final discussion on the limitations of automatic photoelectric guiding.

Instruments used in positional astronomy — the transit circle, the photographic zenith tube, the dual-rate moon-position camera, and the impersonal astrolabe are thoroughly discussed in chapters six, seven and eight. This is a little known field to the amateur, but one of great importance in astronomy, and the details of the measurements and accuracy obtainable with these instruments should prove a revelation to many. With the photographic zenith tube, stars are photographed as they pass through the zenith, or points nearly overhead, by using a high-quality achromatic lens and a reservoir of mercury metal placed below the objective at half the focal length of the lens. Correctly applied, this technique can determine time and position with a probable error over one night of observation of 0.0045 seconds of time and 0.055 seconds of arc!

Astronomical seeing and observatory site selection are covered in chapters nine and ten, and the careful reading of the many components of atmospheric aberrations that contribute to poor images will give any amateur a better understanding of the limitations imposed upon even the most accurate of telescopes.

Radio telescopes are discussed in the last two chapters, and here the reader can find an excellent introduction to the principles and types of this modern astronomical tool. The sensitivity and limitations of these instruments, owing to outside electrical interference, is well presented and brings out the difficulties that modern electrical living and the radiation it emits imposes on radio instruments.

A list of optical telescopes of 20-inches aperture or over throughout the world is given in the appendix, as is also a list of the major radio telescopes and interferometers. This list is complete up to and including 1961, and a perusal of it reveals the size of other large instruments outside the United States, especially the prevalence of catadioptric instruments in the Soviet Union.

Although slanted to the professional astronomer and instrument technician, this new book in the University of Chicago series should provide a most valuable reference source on the shelves of the serious astronomer and telescope maker. Although some sections are what might be considered "heavy" for a beginner, it is the opinion of the reviewer that even the neophyte can find more than his money's worth in this book. It should be in all club libraries, and, if the context of this publication is any indication of the caliber of the subsequent volumes, then it is suggested that organizations consider securing the whole set. During 1961 Volume Two—Astronomical Techniques, and Volume Six—Stellar Atmospheres, will be published, with Volumes Three—Basic Astronomical Data; Four—Clusters and Binaries; Five—Galactic Structure; Seven—Nebulae and Interstellar Matter; Eight—Stellar Structure; and Nine—Galaxies and the Universe, to follow.

ARTICLE REVIEW

"GRAVITY"

Scientific American; March, 1961; George Gamow

By Dr. Carl Kisslinger
St. Louis University

The formulation of the universal law of gravitation by Newton stands as a monument to human intelligence. There is perhaps no better example of the scientific method than the progress from Tycho Brahe's mass of carefully accumulated data, through Kepler's empirical laws of planetary motion, to the culmination in Newton's beautifully simple statement that put order into the wanderings of the planets.

Though there is probably no other law of physics as familiar to every school child as the law of gravitation, the nature of gravitational attraction remains as one of the unexplained phenomena of the physical world. And certainly the beginner in astronomy is often confused when faced with conflicting notions of Newtonian versus Einsteinian gravity, with the attendant discussions of curved space, geodesics in space-time, the gravitational red-shift, unified field theory, etc. Therefore, Dr. Gamow has rendered a valuable service in writing this summary of the development of thought on this subject. In his usual clear style, Gamow discusses the fundamental concepts underlying theoretical and experimental investigations of gravity.

The equivalence of Newtonian inertia and the uniformly accelerating frame of reference is well explained, as is the concept of space curvature. Numerous open questions are indicated, together with the most promising lines of approach to their solution. Of perhaps greatest value is the discussion of the significance of the possible answers to our understanding of the physical world.

The article is recommended to all who seek background for understanding some of the most perplexing problems of modern astronomy, especially cosmology.

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LUNAR OCCULTATION PREDICTIONS — May-June 1961

Station & Location Long. West	Lat. North	Date (1961)	Designation and Catalog Number	Mag.	Phen.	Age of Moon (days)	Time (EST)	Correction Long.	Correction Lat.	Position Angle
A (Massachusetts)		May 15	Alpha Tauri 692	1.1	D	1	17 38.2	−0.4	−1.5	95°
72°.5	42°.5				R	1	18 39.2	−0.2	−1.0	257°
B (Montreal)		May 15	Alpha Tauri 692	1.1	D	1	17 33.5	−0.5	−1.3	87°
73°.6	45°.5				R	1	17 35.8	−0.1	−1.2	265°
C (Wash., D. C.)		May 15	Alpha Tauri 692	1.1	D	1	17 42.1	−0.5	−1.9	110°
77°.1	38°.9				R	1	18 40.6	−0.4	−0.4	243°
D (Toronto)		May 15	Alpha Tauri 692	1.1	D	1	17 32.6	−0.7	−1.5	96°
79°.4	43°.7				R	1	18 36.4	−0.4	−0.9	255°
F (Illinois)		May 15	Alpha Tauri 692	1.1	D	1	17 29.7	−1.0	−2.2	115°
91°.0	40°.0				R	1	18 31.3	−0.9	0.0	235°
		June 21	Gamma Virginis 1821	2.9	D	9	23 47.1	.....	.....	43°
		June 22	Gamma Virginis 1821	2.9	R	9	00 11.6	.....	.....	5°
G (Texas)		June 21	Gamma Virginis 1821	2.9	D	9	23 38.0	−1.6	−0.7	80°
98°.0	31°.0	June 22	Gamma Virginis 1821	2.9	R	9	00 38.6	−0.5	−2.6	327°
H (Denver)		June 21	Gamma Virginis 1821	2.9	D	9	23 21.1	−2.1	−0.2	64°
105°.0	39°.7	June 22	Gamma Virginis 1821	2.9	R	9	00 09.1	−0.5	−3.3	346°
		June 23	74 Virginis 1941	4.8	D	10	01 17.9	−0.6	−3.5	169°
I (N. Mex.-Ariz.)		June 21	Gamma Virginis 1821	2.9	D	9	23 15.2	−2.1	−0.8	85°
109°.0	34°.0	June 22	Gamma Virginis 1821	2.9	R	9	00 23.2	−0.8	−2.7	327°
		June 30	Rho Capricornus 2987	5.0	R	17	06 01.2	−1.2	+0.5	225°
J (Edmonton, Alta.)		May 15	Alpha Tauri 692	1.1	D	1	16 44.1	−1.4	0.0	72°
113°.1	53°.5				R	1	17 59.3	−1.2	−1.1	269°
		June 23	74 Virginis 1941	4.8	D	10	00 35.9	−0.8	−2.0	145°
K (California)		May 15	Alpha Tauri 692	1.1	D	1	16 51.1	.....	.....	136°
120°.0	36°.0				R	1	17 39.3	.....	.....	202°
		June 21	Gamma Virginis 1821	2.9	D	9	22 48.5	−2.4	−0.8	96°
					R	9	00 07.0	−1.2	−2.4	321°
		June 30	Rho Capricornus 2987	5.0	R	17	05 45.7	−1.7	+0.4	243°
L (Oregon)		May 15	Alpha Tauri 692	1.1	D	1	16 34.5	−2.2	−1.0	105°
121°.0	32°.5				R	1	17 50.8	−1.7	+0.9	233°
		June 21	Gamma Virginis 1821	2.9	R	9	23 49.6	−0.9	−2.6	334°
		June 23	74 Virginis 1941	4.8	D	10	00 57.9			175°
		June 30	Rho Capricornus 2987	5.0	R	17	05 44.9	−1.7	−0.1	258°
M (Vancouver, B.C.)		May 15	Alpha Tauri 692	1.1	D	1	16 28.2	−1.7	+0.2	81°
123°.1	49°.5				R	1	17 48.9	−1.5	−0.3	257°
		June 21	Gamma Virginis 1821	2.9	R	9	23 29.2	−0.5	−2.8	348°
		June 23	74 Virginis 1941	4.8	D	10	00 36.1	−0.8	−2.3	160°
		June 30	Rho Capricornus 2987	5.0	R	17	05 40.1	−1.5	−0.3	271°

HOW TO USE THESE OCCULTATION PREDICTIONS

Predictions are made by H. M. Nautical Almanac Office for 12 stations in the United States and Canada. Some of these stations actually lie within certain large cities, but others are merely selected for geographical location and do not coincide with specific cities. Unless you live within a few miles of the points designated by longitude and latitude coordinates of one of these standard stations, corrections must be made to the times given in the above lists.

First, the longitude and latitude of the nearest standard station must be subtracted from your own longitude and latitude. If you are north of the standard-station latitude or north of the standard-station longitude, the sum will carry a minus sign. The difference in longitude is then multiplied by the longitude correction figure given in the tables for your standard station; likewise for the latitude correction. These two quantities are then added, being careful throughout to take into account the plus and minus signs. The sum of these two numbers will be your corrected factor for that occultation, and is subtracted or added, as the signs demand, from the listed time of occultation. These times are only a guide, however, and you should be prepared to begin observations a few minutes in advance of the predicted time.

Occulted stars are designated in most cases by constellation and appropriate Greek letter designation or Flamsteed number. In some cases the *Bonner Durchmusterung* catalog number (e.g., 57° 485) is used for fainter stars. Only stars brighter than 5.0 are published in this selected list. Complete predictions of all observable occultations are published in advance for each year in the December issue of SKY AND TELESCOPE magazine.

The column under "Phenomenon" shows whether the occultation is a disappearance (D), a reappearance (R), or a grazing occultation (G), which may or may not occur for a particular station. Age of the moon is given in days from new moon, and the position angle on the limb of the moon is given in degrees. Position angle is measured eastward from north; orientation can be determined by letting the moon drift through the field of view to establish the east-west axis. Be certain to allow for inversion by the telescope: in a normal situation, looking generally southward from the zenith, north (0°) will be toward the bottom of the field; south (180°) at the top; east (90°) at the right; and west (270°) at the left.

Observations should be sent, as soon after the end of the year as possible, to H. M. Nautical Almanac Office, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, Sussex, England.

This photograph of the inner portion of the Orion nebula was made at the focus of the 7-inch refractor of the Brooklyn College Observatory by several students, and was sent in by Joel Levine.

EDITOR'S NOTE

With the ready availability of fast emulsions, excellent lenses and clock-driven telescopes, the hobby of astro-photography is now within the realm of the average amateur. We are pleased to announce that this department will be a regular feature of each future issue. Possibly the leading amateur authority on astrophotography, Dr. Henry Paul is known as a lecturer and writer in the field, having contributed three chapters to ATM-3 *and recently authored* Outer Space Photography for Amateurs; *Amphoto; $2.50; New York. Dr. Paul will continue to conduct and contribute to this department.*

OUTER SPACE PHOTOGRAPHY

LENSES FOR AMATEUR ASTROPHOTOGRAPHY

DR. HENRY E. PAUL

THE MOST COMMON QUESTIONS from those starting astronomical photography are usually these:

—*What* lens to choose for astronomical objects of their interest.

—*How* to use the lens for best photographic results.

—*Where* to obtain good lenses economically and how to test them.

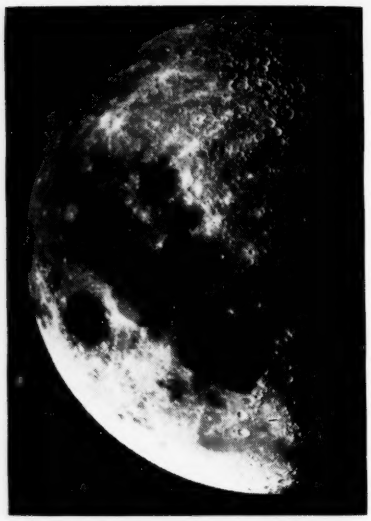
For astrophotography a lens of at least 1-inch effective front opening (clear aperture) should be used. For astronomical objects the angle of view covered with satisfactory sharpness of image is much less (one-half to two-thirds) than that for which an ordinary lens is commonly rated. In fact, a 4 x 5 plate is usually ample to utilize the good field (by astronomical standards) of most ordinary lenses, regardless of local length. Film is usually not held flat enough in camera sizes greater than 2¼ x 2¼—hence plate shou'd be used for the larger frame sizes.

In photographing the stars (point sources) the actual clear aperture of a lens is more important than the commonly expressed speed (f/value) of the lens. The image density of stars increases with the lens area (i.e., in proportion to the square of the lens diameter) and is essentially independent of focal length. Astronomers accordingly rate lenses more often by their diameter (or clear aperture) and focal length than by focal length or f/values.

However, for extended-area objects (nebulae, aurora, comets, etc.) the "speeds," as designated by the f/numbers of the lens, again assumes its importance, as is recognized by any amateur photographer. Lenses for astrophotography are most often used "wide open." However, where sharper definition over a wider field is desired, "stopping down" by one or two aperture stops may be necessary, particularly with lenses of f/2.5 speed or faster. To find the truly effective clear aperture of a lens, divide the focal length by the f/number.

Type and quality of a lens is all-important. In astro-work the best lens obtainable is usually none too good. Care in selection of a lens type most suited for the job at hand will pay big dividends in photographic quality—and personal satisfaction. At this point it should be noted that there is no "all-purpose" astrographic lens. Fortunately for the beginning amateur, the common f/4.5 lenses—as listed here—of 6 inch to 12 inch focal length, are quite suitable for a broad variety of astrographic applications. The readily available 7″ e.f.l. f/2.5 Ektar has wide application for the beginner, since it may be suitably "stopped down" for various subjects. The Schmidt camera combination of a thin lens and a mirror is recommended to the advanced amateur as having definition over medium angles of 10°-20°—far superior to any ordinary lens (see *Amateur Telescope Making—Book Three.*)

The best test of a lens is its performance on the stars, but an approximate idea of performance can be gained by examining the image of a distant (25-50 ft) illuminated pin-



The moon just past first quarter, also photographed by student-amateurs at the Brooklyn College Observatory. Photo furnished by Joel Levine.

Table I

LENSES FOR AMATEUR ASTROPHOTOGRAPHY

Make or Type	Focal length	f/ratio	Comments
Express W.A. (Ross)	5" & 8¼"	4.0 4.0	Good semi-wide angle lens; stop to f/5.6 to cover 4 x 5. 8¼" covers 5 x 7.
Metrogon—W.A. (Bausch & Lomb)	6"	6.3	Good wide angle astro-lens—Covers up to **9" x 9" plate** satisfactorily at f/8—residual astigmatism not objectionable in off-axis images.
Aero-Ektar (Eastman)	7" (also 12")	2.5 2.5	7" is ideal beginner's lens; economical in price; spher. aberr. clears at abt. f/3.5; coma at about f/4.0—best all-around stop; at f/5.6 covers 4 x 5 except corners; where diaphragm not available insert fixed stop between front and rear lens units. 12" similar.
Aero Tessar (B&L) and Aero-Ektar (EK)	24"	6.0	Readily available; judge on individual test basis —can vary; closing ½ stop and/or using red filter plus fast red emulsion (103aE) may greatly improve performance. Also try lt. yellow filter + ortho emulsion with Ektar.
Dallmeyer Telephoto	36"	6.3	Good for narrow angle. Stop to f/8 to reduce spherical aberration. Works best in yellow and red light.
Larger Lenses	40"+	5+	Must test on individual basis, trying various stops and filters to see if useful to you. Buy only on this basis or take a chance.

hole at the focal plane, using a good magnifier to study its definition at varying amounts of lens tilt (from *none* to *half* the planned angle of coverage. Repeat this for various aperture stops. A ground glass at focus can give further information on field curvature, etc. Try several lenses to gain experience. Lenses of 12-inches focal length or more should *always* be purchased subject to satisfactory test.

Data on a few of the most practical lenses which are readily available and now constitute "good buys" for the amateur astrophotographer have been taken from the more complete table in *Outer Space Photography* and presented in Table I.

There is also a broad group of serviceable used f/4.5 lenses of 6- to 24-inch focal length which may appear in camera stores. A few trade names to look for are the Aviar, Ektar, Xenar, Express, Dogmar and Zeiss Tessar. Avoid very fast older lenses, particularly portrait lenses. Stop to f/5.6 or f/8 where greater off-axis sharpness is desired. Low-reflection coatings increase transmission—hence speed.

What lens (or telescope) for what job? Table II gives broad recommendations by area of use in approximate order of increasing challenge. Many generalizations had to be made using ranges rather than specific values. Here lenses, refractors, and reflectors may serve similar functions.

Table II

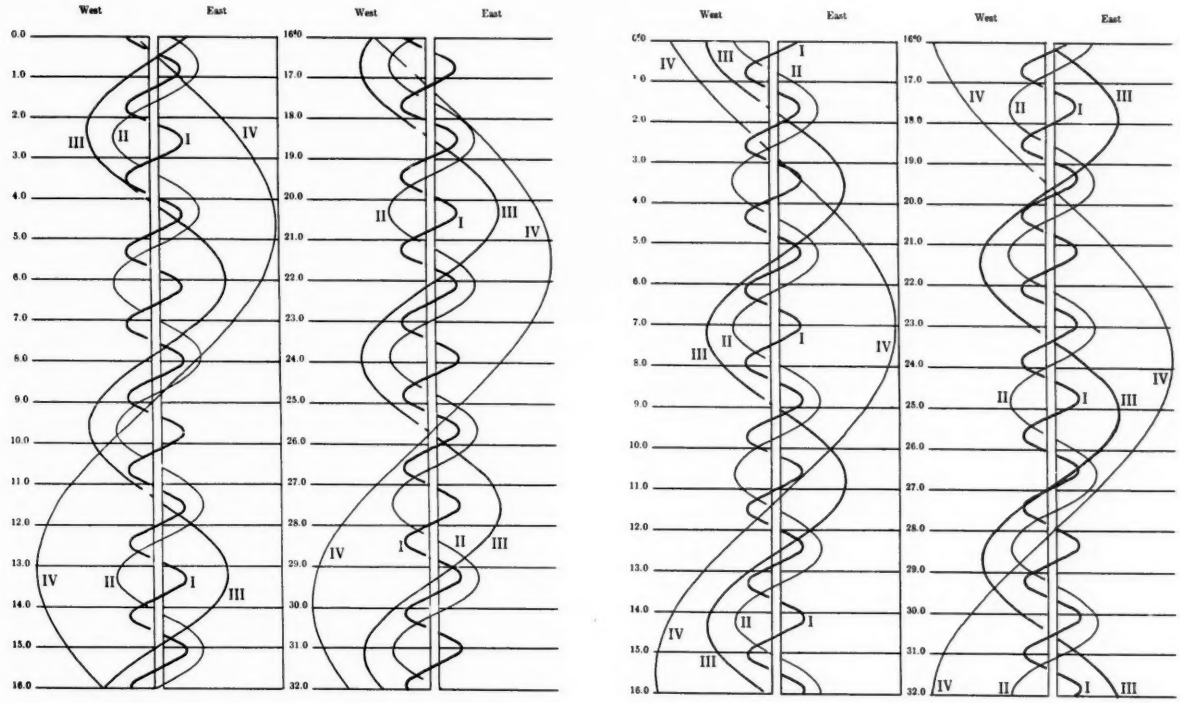
ASTROPHOTOGRAPHY RECOMMENDATIONS

OBJECT	INSTRUMENT	LENS	FOCAL LENGTH	f/NUMBER	COMMENTS
STAR TRAILS	Your camera	As available	Any—i.e. 2"-12" but 5" to 8" good	Wide open but not faster than f/3	An f/4.5 lens covering 40° best.
SATELLITES	35 mm up to 4 x 5 cameras.	f/4.5 or faster	2" to 8"	Wide open	40 to 60° angle of medium coverage okay.
MOON	Camera or scope + camera	Reflector, refractor or telephoto	48" to 100", but at least 20"	f/8-f/15; by amplification to f/60	35mm reflex camera + reflector or refractor ideal.
SUN	Camera + filter; also + telescope.	As above	As above. 3"+ aperture for detail	f/15 to abt. f/60 (totality—open)	As above—amplif. lens for desired magnification.
STARS (general)	Camera (wide angle work)	1" diameter min.— preferably larger	Any—but 5" to 12" best	f/4 to f/8 as req. for definition	Medium speed lens, or stop, for wide angle definition.
STARS (clusters)	Camera + scope (narrow angle)	2" dia. minimum— preferably 4"+	20" or larger	f/6 to f/15	Long focus for greater magnification.
NEBULAE	Camera or camera + telescope	Scopes 2" or more lenses 1" or larger	5"+ for cameras. Short focus scopes	Camera f/2 to f/4.5 scopes f/5 to f/8	Need greatest obtainable light grasp.
COMETS	Camera (+ scope if comet small)	Scope 2" or more lenses 1" or larger	As for nebulae	Usually wide open	Good light grasp and angle to cover object.
AURORA	Camera	1" dia. or larger fast lenses	2" to 8"	Lens wide open; f/2 to f/4.5 best	40-50° angle fast lens.
METEORS	Camera	As available	2" to 8"	f/3 to f/4 best	40° angle of good coverage, as by Ross f/4 W. A. Express
PLANETARY	Scope + camera	for detail 6"+ (minimum 3")	Equiv. focus of 50" to 1000"	f/15 to f/1000 equivalent focus	6" or larger reflector + amplification lens best.

Configurations of Jupiter's Satellites (I-IV)

MAY 1961 JUNE 1961

Universal Time



Observable Phenomena of Jupiter's Satellites

MAY

Date	Time (EST)	Satellite	Phen.
1	02:28	I	Te
8	02:05	I	TI
	03:03	I	Se
10	03:07	II	ED
15	02:41	I	SI
17	02:28	IV	OR
18	03:26	III	ER
19	03:20	II	TI
23	01:54	I	ED
24	01:19	I	Se
	02:30	I	Te
28	02:46	II	OR
29	02:03	III	Te
31	00:57	I	SI
	02:03	I	TI

JUNE

Date	Time (EST)	Satellite	Phen.
1	01:41	I	OR
4	00:08	II	ED
5	01:22	III	Se
	02:06	III	TI
6	00:15	II	Te
8	00:10	I	ED
9	00:35	I	Te
11	02:17	IV	Te
12	01:50	III	SI
13	00:44	II	Se
	02:37	II	Te
15	02:04	I	ED
16	00:05	I	TI
	01:29	I	Se
	02:22	I	Te
19	02:42	IV	ER
20	00:29	II	SI
	02:05	II	TI
21	23:05	II	OR
23	01:06	I	SI
	01:51	I	TI
	02:29	III	OR
24	01:28	I	OR
	22:35	I	Te
29	01:23	II	OR
	23:49	III	ED

(Times EST) E—eclipse (satellite passes into shadow of planet); O—occultation (satellite passes behind planet); T—transit (satellite or satellite shadow passes across disk of planet); S—shadow (shadow of satellite cast on disk by sun); D—disappearance; R—reappearance; I—ingress (entrance upon disk); e—egress (exit from disk). Satellite designations: I—Io; II—Europa; III—Ganymede; IV—Callisto.

EXPLANATION OF SATELLITE DIAGRAM

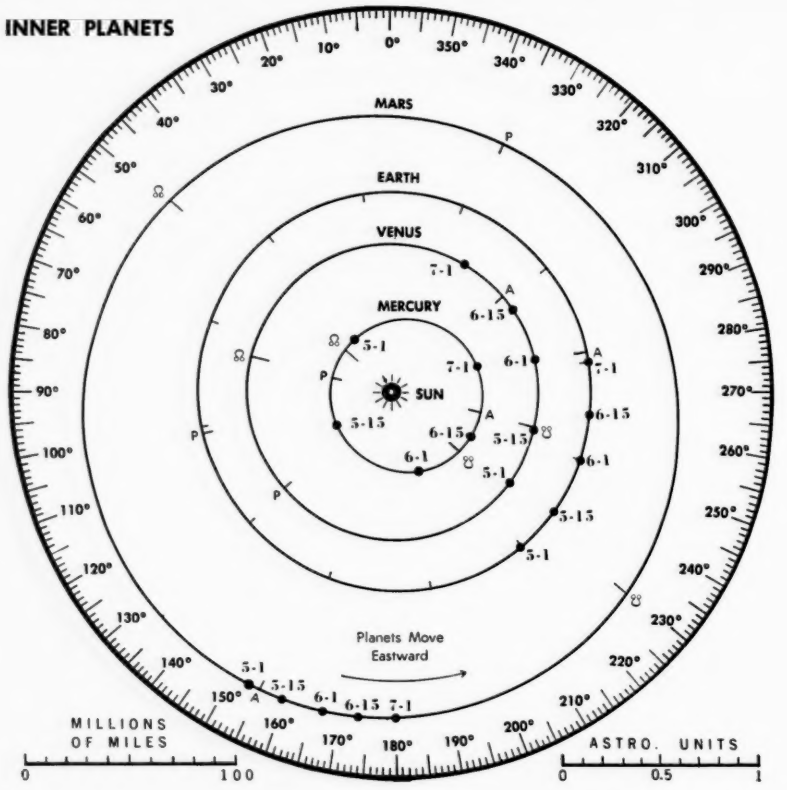
Effective with the unification of the British and American Nautical Almanacs the monthly configurations of Jupiter's bright satellites are now presented in a new and more useful type of diagram.

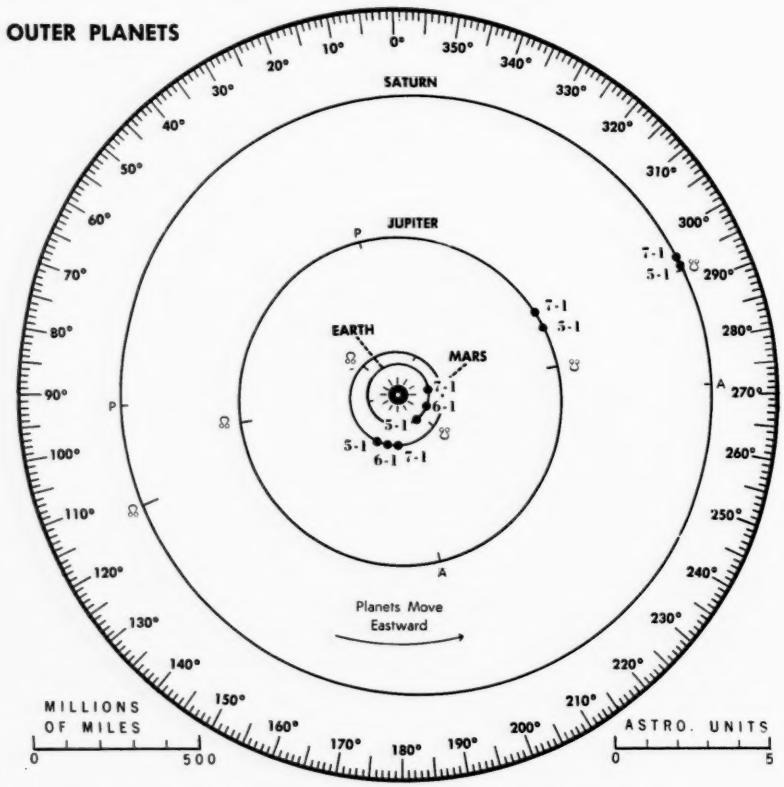
The central vertical band in the diagram represents the equatorial diameter of the disk of Jupiter. The relative positions of the satellites at any time with respect to the disk of Jupiter are given by the curves. In cases where a satellite is immersed in the shadow of Jupiter or occulted by its disk, the curve is interrupted.

The horizontal lines show the positions of the satellites at Oh Universal Time (Greenwich Mean Time) for each day of the month. For example, the horizontal line for the 15th of this month would show the positions of the satellites at 7:00 p.m. on the 14th of the month for an observer in the Eastern time zone.

(Diagrams taken from 1961 *American Ephemeris and Nautical Almanac.*)

Heliocentric Planet Charts for May and June





Presented here are two new charts intended to show the heliocentric and geocentric movements and positions of the naked-eye planets. The upper indicates the orbits of the "terrestrial" planets—Mercury, Venus, earth and Mars—and the lower chart shows the orbits of Jupiter and Saturn, with those of Mars and earth for reference. The orbital positions of the inner planets are shown for the 1st and 15th of each month, from May 1st through July 1st, 1961. The positions of Jupiter and Saturn are shown only for May 1st and July 1st, as their motions are relatively slow. Orbits are to scale.

Scales of distance in astronomical units (mean distance from earth to sun: 92,900,000 miles) and millions of miles are included for each chart, and can be used to measure approximate distances between any pair of planets, or planets and the sun. The nodes are indicated so that one may determine upon which side of the ecliptic, north or south, a planet will be found. Moving eastward, a planet, having crossed the ascending node (☊), will be *north* of the ecliptic, until it reaches the descending node (☋), when it crosses to the *south* until it passes the ascending node again. Positions of perihelion (P) and aphelion (A)—closest and farthest distance from the sun—are indicated by the appropriate letter and a long tick.

Progress of the planetary rhythms can be followed with considerable exactitude from month to month. Their configurations — conjunctions, oppositions, elongations, passages of perihelia, for example — should be easily noted. The interested reader will discover much other useful information that can be gleaned from study of this regular new feature.

Heliocentric and Geocentric Longitudes

The heliocentric longitude (i.e., as seen from *sun*) of a planet at any time can be read from the charts by drawing a straight line from the center of the sun through the planet and intersecting the outer scale of longitude at the required point. Dates between those indicated for any planet can be interpolated, or estimated.

An example of this simple and useful calculation can be found on page 24 of the March-April issue.

METEOR FRAGMENTS

ETA AQUARID SHOWER

THE ETA AQUARIDS will come to maximum on May 4th, when the rate, according to Peter M. Millman in the 1961 *Observer's Handbook* of the Royal Astronomical Society of Canada, should be about 20 per hour. The radiant, which lies close to the equator of the sky and at RA 22.4 hours, rises at about 2 a.m. in all latitudes where observers are likely to be found. The radiant area is always in or near the Water Jar of Aquarius.

Investigation shows that this is a shower which is much better observed in low northern, equatorial and southern hemisphere latitudes. At latitude 40° N., the radiant is only about 15 degrees high, at the beginning of astronomical twilight, while at the equator it is just above 40°; and at latitude 40 S., just below 40° in altitude. The point is clear, then, if it is remembered that the observed rate of a shower is higher as the angular distance of the radiant above the horizon increases.

The Eta Aquarids have a broad maximum, extending from about April 25th to May 13th. The moon will interfere during the period before maximum, but not seriously after. The meteors are exceptionally pretty, as they leave very long streaks. Some investigators believe that this stream is possibly associated with the famous Halley's Comet.

EDWIN E. FRITON
Regional Director
American Meteor Society

SKY WATCHER'S DIARY

MAY

Date	Hour (EST)	Event
1	18	Mercury in superior conjunction
6	07	Saturn 3° S. of moon
	07	Moon in perigee
	19	Jupiter 3° S. of moon
7	11	Last quarter
9	16	Saturn stationary
11	11	Venus 4° N. of moon
14	12	New moon
15	17	Mercury 7° N. of Aldebaran
	17	Mercury 7° N. of moon
	17	Aldebaran 0°.5 S. of moon
16	15	Venus greatest brilliancy
20	13	Mars 4° N. of moon
21	00	Moon at apogee
	14	Pluto stationary
	17	Uranus 2° No. of moon
22	08	Regulus 0°.7 N. of moon
	11	First quarter
25	20	Jupiter stationary
27	19	Neptune 3° S. of moon
30	00	Full moon
31	23	Mercury greatest elongation

JUNE

Date	Hour (EST)	Event
1	22	Moon at perigee
2	13	Saturn 3° S. of moon
3	01	Jupiter 2° S. of moon
5	16	Last quarter
9	04	Venus 2° N. of moon
12	00	Aldebaran 0°.5 S. of moon
13	00	New moon
14	05	Mercury stationary
	13	Mercury 3° N. of moon
15	19	Mars 0°.6 N. of Uranus
17	17	Moon at apogee
18	02	Uranus 1° N. of moon
	05	Mars 2° N. of moon
	15	Regulus 0°.5 N. of moon
19	21	Venus greatest elong. W.
21	04	First quarter
	11	Summer solstice
24	04	Neptune 3° S. of moon
27	03	Mars 0°.7 N. of Regulus
	07	Mercury in inferior conjunction
28	08	Full moon
29	19	Saturn 3° S. of moon
	20	Moon in pergee
30	07	Jupiter 3° S. of moon

(In areas using daylight saving time observers can convert by using the standard time of the zone to their east — for example, CDT = EST, PDT = MST, etc.)

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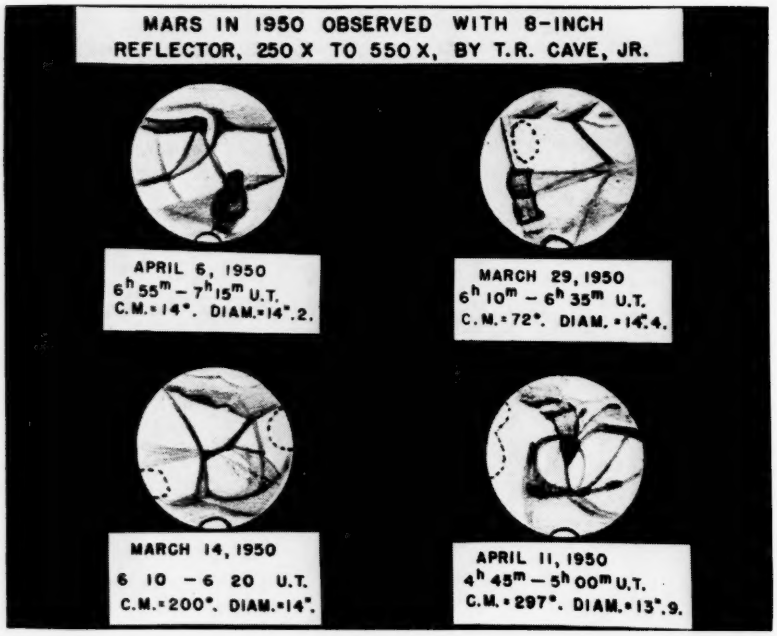

MARS IN 1950 OBSERVED WITH 8-INCH REFLECTOR, 250 X TO 550 X, BY T.R. CAVE, JR.
APRIL 6, 1950
6h 55m – 7h 15m U.T.
C.M. = 14°. DIAM. = 14".2.
MARCH 29, 1950
6h 10m – 6h 35m U.T.
C.M. = 72°. DIAM. = 14".4.
MARCH 14, 1950
6 10 – 6 20 U.T.
C.M. = 200°. DIAM. = 14".
APRIL 11, 1950
4h 45m – 5h 00m U.T.
C.M. = 297°. DIAM. = 13".9.

Mars requires (and bears) fairly high magnifications, as indicated in these excellent drawings by the author. Cave used different magnifications for various details, but used lower powers for general disk detail.

YOUR TELESCOPE AND MINE

By Tom Cave

USEFUL MAGNIFICATIONS IN OBSERVING

Probably the first major misconception encountered by the budding amateur astronomer is that concerning magnification. The uninitiated amateur too often buys his first telescope largely on the basis of its advertised power. The magnifying power of any telescope may easily be determined by dividing the focal length of the objective lens or mirror by the focal lengths of the eyepieces. The shorter the focal length of the eyepieces, the higher the magnification. By obtaining a lens or mirror with a focal length of 100 inches and then using a very short focus eyepiece of about 1/10" focal length, the resulting power would be 1,000. Such a magnification, except under the most ideal "seeing" conditions, would be sheer folly. Powers of 1,000 and more, even when used on large telescopes, are nearly always used only by astronomers who specialize in the study and measurement of close double stars; and in this work, on very rare occasions, powers as high as 2,000 to 3,000 have been employed. During the last 15 years the planetary observers at the Pic-du-Midi Observatory in France—at an elevation of over 9,200 feet, have occasionally used powers of 1000x to 1600x in the study of fine detail on Mars and details on the four large satellites of Jupiter.

Nearly all visual work done by professional and amateur astronomers is accomplished using powers of about 600x and lower; and about 90% of the time the power is below (much below) 600x. The small 3- to 6-inch first-quality telescopes found in the hands of amateurs are quite capable, on good nights, of using powers from 200x to 400x with excellent definition—or up to about 70x per inch of aperture. As the aperture of the telescope is increased the usable power per inch decreases; and above 12-16 inches of aperture about the same range of magnifications as applied to smaller instruments are used for most visual observing. An excellent example of this was noted years ago by the author—who had usually employed 300x to 500x with a 12½-inch reflector for observing Mars—when he found the same general range of magnification used by the astronomers at Lowell Observatory for work on Mars with the famous 24-inch Clark refractor.

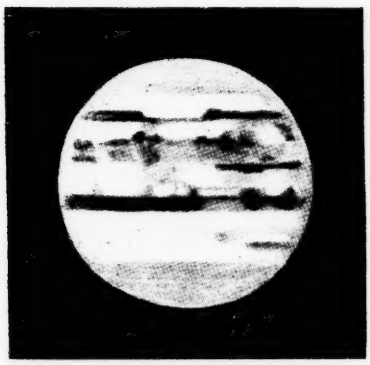
A good rule of thumb to follow with any small telescope is that about 50x per inch of aperture is the upper useful limit of magnification, and even 30x per inch will be found much more satisfactory in apertures above 8 inches. An observer must employ about 16x per inch of aperture in order to attain the full resolution of any telescope. Theoretically, 16x per inch should be sufficient magnification to observe all the visible plan-

SUGGESTED MAGNIFICATION RANGES BY OBJECTS*

Object	Small Apertures (3-4 inches)	Moderate Apertures (5-12 inches)
Moon (detail)	180x-240x	300x-400x
Moon (occultations)	75x-100x	75x-100x
Mercury (light sky)	100x-150x	135x-180x
Venus (light sky)	120x-160x	200x-400x
Mars	120x-200x	150x-300x
Jupiter	120x-200x	150x-300x
Saturn	150x-200x	200x-400x
Uranus (disk)	180x-240x	200x-400x
Close doubles	(60x-100x per inch of aperture)	
Wide doubles	(Just enough to separate components)	
Comets	30x- 80x	30x-100x
Variable stars	30x-100x	50x-120x
Sunspots	60x-100x	60x-180x

*This list of suggested magnifications is a distillation of the experience of a number of British and American observers. Effective magnifications will vary with experience of observer, detail being sought, focal length of instrument, altitude of object, atmospheric seeing, quality of optics and other factors. Powers indicated are to guide average observer under average conditions.—Editor.

etary detail with a given aperture. In practice, however, this is always found to be far too low. Most experienced observers prefer about 25x to 40x per inch, since the planetary image is then considerably larger and the detail more easily seen. Another bad effect always noticed with increased power is the weakening of contrast, causing much faint detail to disappear completely as magnification is pressed too high. Under all but the best atmospheric conditions, powers above about 30-40x per inch become empty magnification, marring the visibility of fine details and tending to soften or blur the planetary disc. Once the optimum magnification is reached, increase of *aperture* rather than power is the only answer—assuming the observer is experienced and the best atmospheric conditions prevail.



Jupiter, as observed and drawn with a 4-inch refractor (200x) by British observer G. E. D. Alcock, Dec. 8, 1952. Per-inch power can be pushed higher on smaller apertures than on moderate apertures. From BAA Journal.

Recently Mr. Steven Sullivan of Kearny, N.J., has written us regarding old refracting telescopes which do not bear the maker's name or other identification. Since many of the Clark and Brashear refractors were made between the early 1870's and the turn of the century, many of these fine instruments have undoubtedly been modified or remounted over the years, and in some cases the maker's name has been removed. At one time a number of telescopes of small size made in France were imported into the United States without the manufacturer's name. Although this was not common practice, there are probably a number of French refractors manufactured by the leading optical houses in Paris which were never inscribed. These may have been made by Bardou, Secretan or Vion. Also, in the 1930's, Janan imported telescopes in New York, some of which did not bear the manufacturer's name.

Nearly all of the older refracting telescopes occasionally found on the market are more valuable as collector's items when they carry the original manufacturer's name. However, none of these instruments should be condemned until thoroughly tested by a qualified authority. Occasionally, very fine bargains may be picked up in old instruments which do not have the maker's name suitably inscribed. The author has known of several Clark refractors, modified many years ago by subsequent owners, which today do not bear the name Clark but which were made, without any doubt, by Alvan Clark and Sons Company in Cambridgeport, Mass. It is always an excellent idea when purchasing a refracting telescope—unless it may be obtained at a truly bargain price—to insist upon a good name, such as Unitron and other top-grade refracting telescopes available in this country today.

We have also received an inquiry recently about the possibility of adapting variable-power telescopes to higher magnifications than normally manufactured. Most of these instruments are of the marine spy-glass design and have a built-in eyepiece magnification lens system just ahead of the eyepiece. It is usually quite difficult, without entirely remaking the instrument, to increase the magnification of such a telescope. Modification of such a telescope usually greatly reduces its resale value; and since most of these telescopes were manufactured for terrestrial use only, the highest power normally applied ranks from 30 to 50 power as the upper limit.

Questions from readers are now being received by the writer in increasing number, and in future issues more space will be devoted to answering questions regarding telescopes, their design, performance and use.

(Queries to Mr. Cave should be directed to him in care of this magazine. All letters will be answered personally, and those of general interest will be included in his discussions in future issues.)

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NOTES ON FIRST TELESCOPES

ROBERT E. COX
McDonnell Aircraft Corp.

ONE OF THE BIGGEST DECISIONS to be made by the beginning amateur is that of securing an instrument for observing. Should it be a commercially made instrument, so many of which are available on the market today at such reasonable prices, or should it be made in the basement, or under the instruction of experienced telescope makers in the local society? If one has mechanical ability—even the slightest is all that is necessary—then the satisfaction obtained from personal construction is difficult to ignore. However, if one is impatient to observe, then the delay for fabrication may either discourage one's interest or cause the intrument to be completed in a haphazard and careless manner. This results in poor images and operation, and soon dampens all but the most enthusiastic.

It would appear that a compromise is needed, a low-cost small or moderate-size telescope being purchased while preparing a more powerful observing tool under the proper conditions and instruction necessary for high-quality optics.

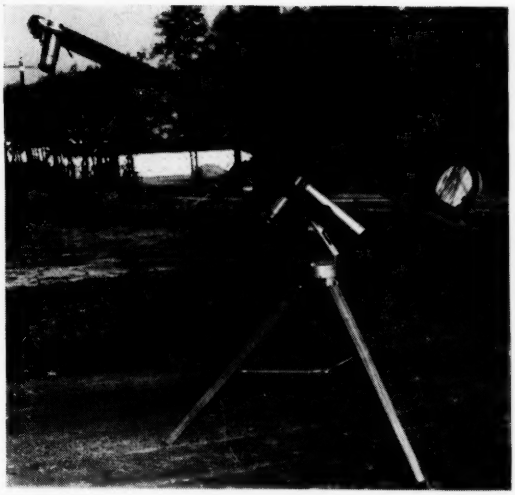
A 3-inch or 4-inch long-focus spherical mirror, either purchased in a complete telescope or acquired separately and mounted by the amateur, makes a fine beginning instrument. It will take the beginner considerable time to exhaust the possibilities of one of these reflectors, as the reader will discover in the "Through The Three-Inch" feature that appears regularly in this magazine. Of course, a 3-inch refractor makes a superb telescope, too, and for planetary and lunar observations its use is highly recommended. If one is planning to purchase a small-aperture instrument, the refractor should definitely be seriously considered.

Let us assume that one wishes to build his first telescope and that a reasonable amount of time is available. A 6-inch reflector has been the standard selection for the past decade. However, if one is not planning a second or subsequent array of instruments, an 8-inch mirror is being recommended by many lately. To this writer—being an active telescope maker for over 25 years—the idea of making only one mirror seems so incomplete that for purposes of this discussion we will consider the 6-inch and hope that a further excursion into the field of optics will follow at a later date.

A first endeavor should be as simple as possible, yet still yield a precision optical instrument that can perform to and even beyond the beginning observer's capabilities. The delicate touches that must be applied to change a spherical surface into a perfect paraboloid on the standard 48"-focus 6-inch, f/8 mirror—11.4 millionths of an inch—has caused many an amateur such anguish that his project has collapsed and been permanently abandoned. If such a mirror is constructed to an f/9 or even f/10 ratio, then its surface can be left spherical and still give excellent performance. The f/10 focal ratio is recommended for its higher correction, but such a long tube may cause mounting and handling difficulties, in which case the f/9 ratio should be used. In the crowded condition of apartment house living in New York many an amateur there has settled on a short-focus, parabolized mirror, there not being room for a long tube length.

We will assume crowded housing and observing conditions and work for the f/9, or 54" focus mirror. However, with slight modifications in figures, the techniques discussed apply just as readily to the f/10 mirror.

A long focal length, besides having the advantage of not needing to be parabolized, also requires less grinding, and it is possible to put the curve in the surface with an abrasive powder considerably finer than that necessary for a shorter-focus instrument. It is entirely feasible to use a No. 120 smoothing grit and obtain a shallow curve, thus saving the worker the time and trouble of removing the heavy pits caused by coarse, roughing-out abrasives. In



This beautifully mounted open-construction f/10 6-inch shows that the skeleton-tube style is not to be shunned. This fine instrument was built by G. Audy of Wilmington, Del., who exhibited several larger instruments at the Haverford convention of the Astronomical League last September.

average grain size this represents a difference of about 0.006″. The most important point to remember is not to be impatient and rush ahead too fast; time and patience results in the best telescopes.

Either one of two books is recommended as a guide in construction, "Making Your Own Telescope," by A. Thompson, available from the Sky Publishing Corporation for $4.00, and "How to Make a Telescope," by J. Texereau, from Interscience Publishers, Inc., New York for $3.50. Both of these volumes present the complete process of mirror-making and mounting design in a concise and logical manner, but the less mathematically minded worker wil find the Thompson book somewhat easier to understand and apply.

Some materials on telescope making suggest polishing the mirror and not optically testing it for surface smoothness and figure. Even the finest optical worker in the world cannot produce a good spherical surface on a standard mirror just by watching to see that the polish comes up in a regular fashion. It is suggested that a slit be placed at the center of curvature of the mirror and a single fine wire (diameter about 0.010″) be used as a simple Ronchi test. If the wire is straight when it is advanced through the returning beam of light from the mirror, then correction is satisfactory. Details of this test can be found in "Amateur Telescope Making—Book One." However, the Foucault knife-edge test can and should be applied by the inexperienced optical worker. Details are available in any book on telescope making.

Too many telescope mirrors lie around awaiting a mounting while the amateur slowly becomes discouraged. Few realize that a good equatorial mounting is a major part of constructing a telescope, and unless one is a first-hand mechanic or engineer with a good machine shop available it can be an involved project. It is recommended that one first build a simple tubeless mounting of the type illustrated here. Even an altazimuth mounting is satisfactory for a beginning. Then, while getting experience and enjoying the optics in their inexpensive mount, one can take the time and expense to construct a good equatorial.

A final word about accessories. as discussed in the last issue, the eyepiece is all-important in the final operation of a telescope. For low-power applications a war-surplus long-focus eyepiece is satisfactory, but for high-power use an orthoscopic eyepiece is recommended. An achromatic Barlow lens with medium-power eyepiece gives a fine high-power combination for viewing, with adequate eye relief behind the ocular for those wearing glasses. Incidentally, if you have a simple correction without the complications of oblique astigmatism, prisms and such, then it is better to view without your spectacles, refocusing to obtain a sharp image.

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AMATEUR'S FORUM

(Continued from page 3)

Gentlemen:

From 'way back in the days when the MONTHLY EVENING SKY MAP was just that and nothing more, I remember using enjoyably the chart showing the heliocentric positions of the planets. It was a very sensible setup for not-too-bright amateurs like myself, easy to use and understand, and quite rewarding.

Now you have ruined the whole thing. God knows what possesses people who must always change everything and "improve" it to the point of unusability.

What raw amateur goes out under the sky knowing the direction to look for a planet with such-and-such helicentric longitude? For Heaven's sake, man, put back the zodiacal constellations. Put back the dates on Mercury ad Mars. Put back the old chart, or count me out as one of your friends and boosters.

R. S. Dodson, Jr.
Starlook Cottage
Pittsboro, N.C.

Come now, Mr. Dodson! Let's not let the new charts come between old friends! There was a very good reason for the change, and we've had a number of letters from pleased readers. The old charts were not designed for locating the planets in the sky, nor are these. Our equatorial charts take care of that. The old charts were not to scale, so did not show the relationships between the earth and the other planets. For example, you could not anticipate a conjunction of Venus and Jupiter from these charts—with the new diagrams the orbits are to scale. Actually, that is the only real difference between the two. We hope you'll meet us half way on this!

Dear Sirs:

I received my new REVIEW OF POPULAR ASTRONOMY. It is a great aid to me. I have viewed many wonders since I had received my first copy last year. I have seen the Orion nebula in Orion's sword, but I have not been able to find the Horsehead nebula. Could you please help me? I have a 3-inch and an 8-inch telescope.

Richard Counceller
R. R. No. 1, Box 576
Anderson, Ind.

Under normal conditions and instrumentation the Horsehead nebula is not an easy object for small instruments. We have glimpsed it under exceptional sky conditions using a 6-inch richest-field telescope, but it is not readily within range of modest apertures. It is always a problem for the beginner to relate the long-exposure photographs he sees to the view in his telescope. While this can be misleading and disappointing at first, you will find that an actual view of an object in your own instrument, faint as it might be, often means more than a 200-inch Mt. Palomar photo on the printed page. Each has its value, but cannot be compared.

Dear Sirs:

I'm a new subscriber and an amateur of questionable understanding. Features like "Through the Three-Inch" and "Selecting Eyepieces and Accessories" are an inspiration and a source of wisdom that this owner of an 8" reflector (homemade) has been seeking. Please keep this type of information flowing.

Leslie G. Dick, D.D.S.
200 Donaldson Ave.
San Antonio 1, Texas

Dear Sirs:

May I add my belated word of praise to the many I'm sure you've already received on the new title that has been added to the new look of your publication. It is a very fine magazine, and I expect it is making quite an impact on the legions of amateur astronomers. Best of luck to you.

Roland D. Paine
Press Officer
National Science Foundation
Washington 25, D.C.

Dear Sirs:

I would like to thank you for putting out such a well written magazine. It is a pleasure to read.

Lt. Mark Hughes
85 Matheson Road
Columbus, Georgia

Gentlemen:

I hope these drawings of Comet Candy will be of use. I belong to the ALPO and also to the AMS, for which I chart meteors. I have read your article on "the Three-Inch" and have enjoyed it.

I might add that I have seen at the present 94 objects on Messier's list. I have seen countless Herschel objects and have made drawings of them. I have seen the 9th, magnitude star in the nebula H-IV 45, or NGC 2392 in Gemini. You asked about this in the last "Through the Three-Inch" article. I would be glad upon request to send in reports on deep-sky objects or such for that article.

Larry Anthenian
1725 Hicks Ave.
San Jose 25, Calif.

Mr. Anthenian did a thorough job of observing and sketching Comet Candy. His work has been passed on to Mr. Meisel of the ALPO. He is also rather close to completing his survey of the Messier list of nebulae, galaxies and clusters. Many individuals and clubs have made a project of this; it is excellent experience and training. We would also like to encourage reports of fainter objects glimpsed in small instruments for later use in the magazine.

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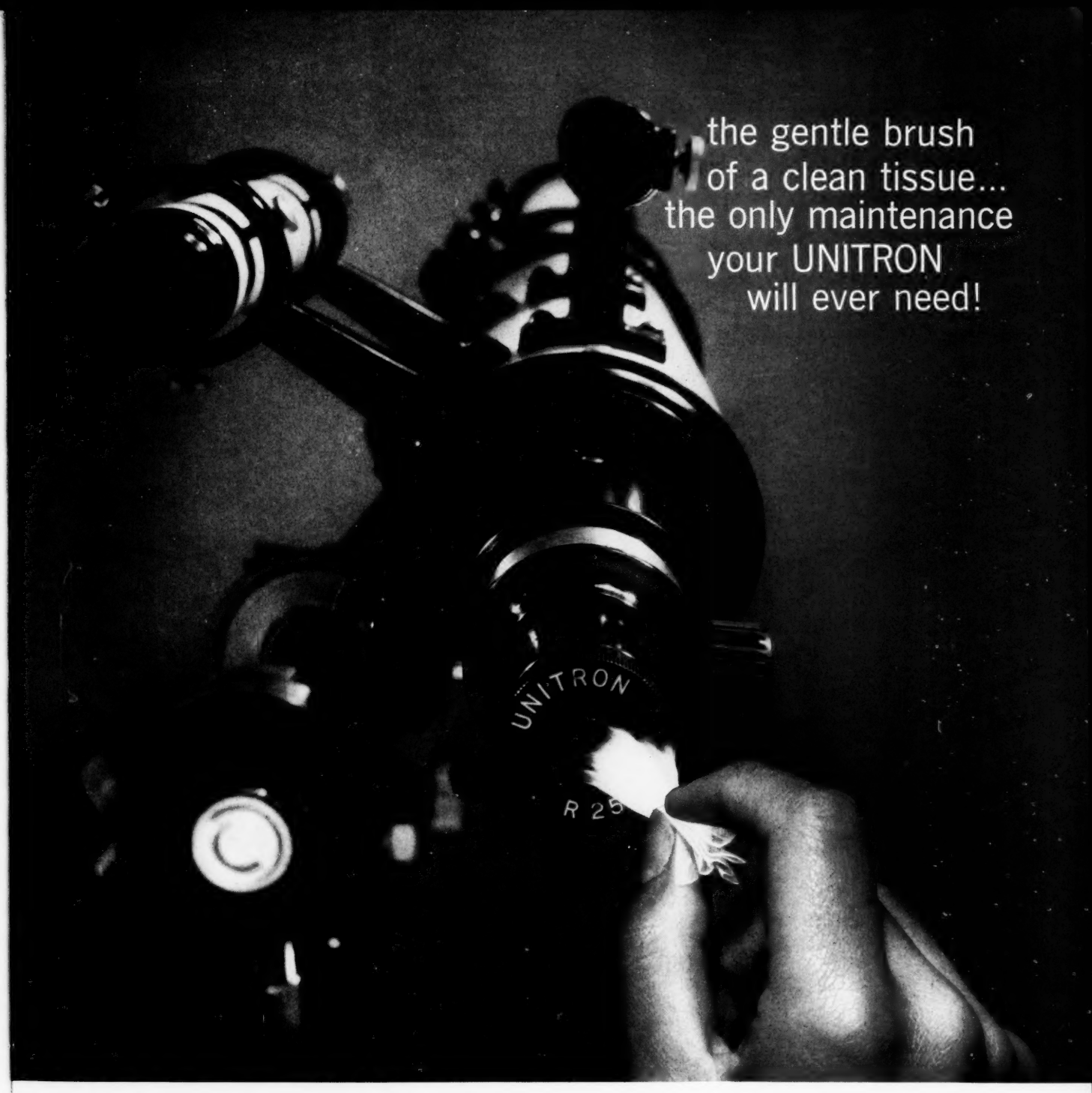

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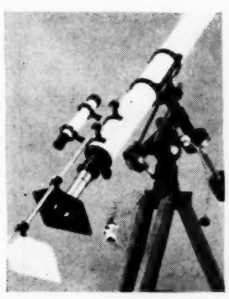

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